

Covering the Period July 1, 1970 - June 30, 1971

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Annual Report

July 1971

Covering the Period July 1, 1970 - June 30, 1971

ACTIVITIES OF THE NASA-SPONSORED SRI TECHNOLOGY APPLICATIONS TEAM IN TRANSFERRING AEROSPACE TECHNOLOGY TO THE PUBLIC SECTOR

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Prepared for:

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TECHNOLOGY UTILIZATION DIVISION
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WASHINGTON, D.C. 20546
Attention: MR. ROYAL G. BIVINS, JR.

CONTRACT NASw-1992

SRI Project PYU-8368

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PREFACE

The NASA Technology Applications Team at Stanford Research Institute has been active in the technology transfer program since July 1, 1969 under Contract NASw-1992. The main mission areas of this team are criminalistics, transportation, and the postal services.

The members of the core TATeam at SRI are

Charles J. Cook, Ph.D., Program Supervisor and
Executive Director, Physical Sciences Division

Joseph G. Berke, M.S., Program Director

Brian Parker, D.Crim., J.D.

Richard Blunt, B.S.M.E.

Michael Torgersen, B.S.M.E., M.B.A.

Ruth Lizak, Research Assistant

The objectives of this program are to transfer aerospace technology for the solution of important technological problems in the three public sector areas above and to implement and continuously refine appropriate methodologies, and mechanisms to ensure successful transfers and provide appropriate visibility for program activities.

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I THE EVOLVING TATEAM METHODOLOGY

A. Introduction

The National Aeronautics and Space Administration's Technology Utilization Office (TUO) has organized small interdisciplinary teams at research institutions throughout the United States to develop and apply effective methodologies for solving discrete technological problems within the public sector through the application of aerospace-generated technology. These Technology Applications Teams (TATeams) are actively effecting such transfers in areas that include air pollution, water pollution, transportation, mine safety, criminalistics, law enforcement, urban construction, and the postal services.

An interdisciplinary TATeam was formed at Stanford Research Institute to develop and conduct a program for not only optimizing the match between public sector technological problems in criminalistics, transportation, and the postal services and potential solutions found in the aerospace data base, but ensuring that appropriate solutions are actually utilized. SRI's efforts during the first formative year of the program have been documented in an annual report covering the period July 1, 1969 to June 30, 1970. The second year's activities, under Contract NASw-1992, have resulted in expansion, reevaluation, and refinement of much of the first year's work. This annual report, covering the period from July 1, 1970 to June 30, 1971, describes the work accomplished by the Team during the second year of the program.

B. Background

Successful technology transfer may be defined as the application of new technology into areas other than those for which the technology was originally created or intended. This definition implies that new areas of application, beyond the original, initial area of mission orientation, are found for given items of new technology, that the technology is directly suitable or is made suitable for the new applications, and that those responsible for the new applications area are persuaded to use the new technology in actual practice.

The actual practice of transferring technology may be of two kinds: active or passive. Passive technology transfer requires only that the storehouse of accumulated technological information be made available to interested potential users on demand. Technological information is transferred by reports, personal exchange, or any mechanism that permits diffusion. This is a relatively low cost activity and is undertaken by many organizations through such services as the Defense Documentation Center (DDC), the National Technical Information Service, and NASA through its Scientific and Technical Information Facility (STIF) and six Regional Dissemination Centers. It is generally necessary to maintain an extensive data base and utilize a complex literature retrieval system. The user must formulate his problems in terms of the indexing terminology understood by the retrieval system. These searches sometimes do, but frequently do not, produce results that the user can apply directly. Some of the obstacles to successful literature searching by computer are use of inadequate descriptors in compiling the data base, differences in terminology, and the high technical level of the literature.¹ In particular, from a user's viewpoint, there is the problem of the difference in missions and goals between the original technology (apparently abstruse in nature) and the subsequent practical applications. Even when such passive technology transfer includes "high potential"

publications such as NASA's Tech Briefs and Special Publications, it is hard to assess the utility of these endeavors.

As a result of the inadequate number of transfers obtained from the vast storehouse of government-generated technology by passive methods, attempts have been made during the past five years to initiate active technology transfer programs. Although these programs have not yet achieved their full potential, it is becoming evident that they hold promise of achieving benefits much greater than their cost.

One of the nation's most notable active technology transfer programs is being undertaken by the Technology Utilization Office of NASA. Bio-medical Applications Teams (BAT) and Technology Applications Teams (TAT) are the central element in this program. These teams are staffed with scientists, engineers, businessmen, and biomedical specialists. They are "transfer agents" within their respective mission areas and their task is to expedite the process of technology application. Indeed, it is their task to bring about actual transfers which are viable in the marketplace. To do this, they must identify and understand user problems, restate them as needed to overcome vocabulary barriers, and find potential aerospace solutions through efficient literature searches, and very importantly, by personal interaction with experts in the NASA community. When a potential solution is found, the Team must evaluate it, adapt or assist in adapting it to suit the new application, and persuade the user to devote the needed effort and funds to put the solution into practice. Failure or inability to perform any of these functions in a timely manner can inhibit the achievement of a transfer. Transfers (which are essentially solutions to current problems using existing technology) are very fragile because of the time factor. A delayed transfer often results in a totally missed transfer, hence a missed step in technological development or a missed economic opportunity for the user.

The specific experiences of the SRI TATeam, which we feel indicate some success in developing a useful transfer philosophy and methodology within our mission areas, are brought out in the ensuing discussion. It will become evident that each mission area generally requires a specialized set of operational procedures.

C. Program Evolution

The TAT program was preceded by the BAT program, by approximately four years. The success in transferring aerospace technology to the biomedical community using refined approaches to problem definition/technology match led to the design of a similar program to maximize the return on the public investment in aerospace technology by using this technology to solve problems in various public sector areas of concern. The initial TAT operating procedures were predicated on those of the previous BAT efforts. After a short time, however, it was evident that certain changes were necessary to modulate particular TAT efforts to fit particular public sector environments and needs.

As had been the case with the startup of the BAT program, new languages had to be learned to gain familiarity with the user's field (for example, rumble strips and gore areas in highway work, city scheme and letter mail code sort systems in the postal service, and fingerprint minutiae and ballistic striae in criminalistics). These languages must be understood before relevant aerospace technology can be translated and brought to bear on user problems. In addition, a facility with the "jargon" of a particular field increases the user's confidence in the Team and in its ability to help with specific problems. Such a confidence tends to bring out the more immediate problems rather than the long-standing and perhaps insoluble problems which are not necessarily in the forefront of the user's concerns.

By the end of this second year, many of our more recent users were referred by satisfied users already in the program. One of the most notable referrals was the Association of American Railroads, referred by the Federal Railroad Administration in Washington, D.C. Associations frequently have the potential to implement new technology more rapidly than a governmental public sector agency. This will be considered in greater detail later.

A second factor in the TATeam's start-up was the gaining of a working knowledge of the NASA data base and NASA Field Center staff functions and expertise. Much of the success of this second year's work was the result of an ability to pinpoint NASA expertise, present the problem on a person-to-person basis, and show down-to-earth relevance to a scientist's mission. The Team was thereby able to reduce the time from problem origination by the user to presentation of a potential solution. Again the user's confidence in the program was increased. Furthermore, it became evident that NASA Field Center personnel were developing confidence in the Team as a result of personal interactions regarding matters of public sector concern and appreciative feedback by user agencies. On many occasions we have received unsolicited information from a scientist, information he thinks may be applicable in the team's mission area. For example, Ames Research Center personnel brought their work on brake lining materials to our attention as a possible solution to problems in transportation and the postal service vehicle fleet.

An active technology transfer effort such as the TATeam program is built around a catalytic third party, the transfer agent. Technology made available in a passive transfer program can go unnoticed if there is no active catalyst such as described above. The transfer agent, by having the confidence of the potential user and the trust of the technology source, can successfully bridge the communications gap that otherwise tends to be inherent between technology user and technology source.

He can, therefore, make the difference between success or failure in a technology transfer program.

D. Problems and Solutions

Early in the program when the degree of user confidence was still questionable, criteria for the selection of problems were accepted on almost any subject that could be injected into the search process to generate results for the user. During this period a basic Application Team methodology was followed (Figure 1). This was necessary to develop an expertise in retrieving any relevant solutions. A large amount of time was spent in preparing Problem Statements.* Searching of the NASA computerized data base required a certain amount of training. During these early stages, the search strategies were formulated by RDC staff members directly from the Problem Statements. This proved to be a very inefficient process. Most of the problems in the Team's mission areas do not have exact parallels in the NASA community; therefore, there is a tendency to conjure up potential solutions or to delimit the areas in which potential solutions might occur in order to make possible the search for analogous information. Because the language is not always precise in terms of nonaerospace contexts, the search strategies are not sufficiently selective, and long lists of irrelevant citations can appear. For example, the term "integration" or integrator may refer to a mathematical process, a mechanical device, a computer program, a systems engineering activity, or general management. Citations for articles in each of these areas may appear, for example, when only mechanical devices are of interest.

* A Problem Statement is a one- or two-page description of the problem. It generally includes background information, constraints and specifications, and possible approaches for solving the problem.

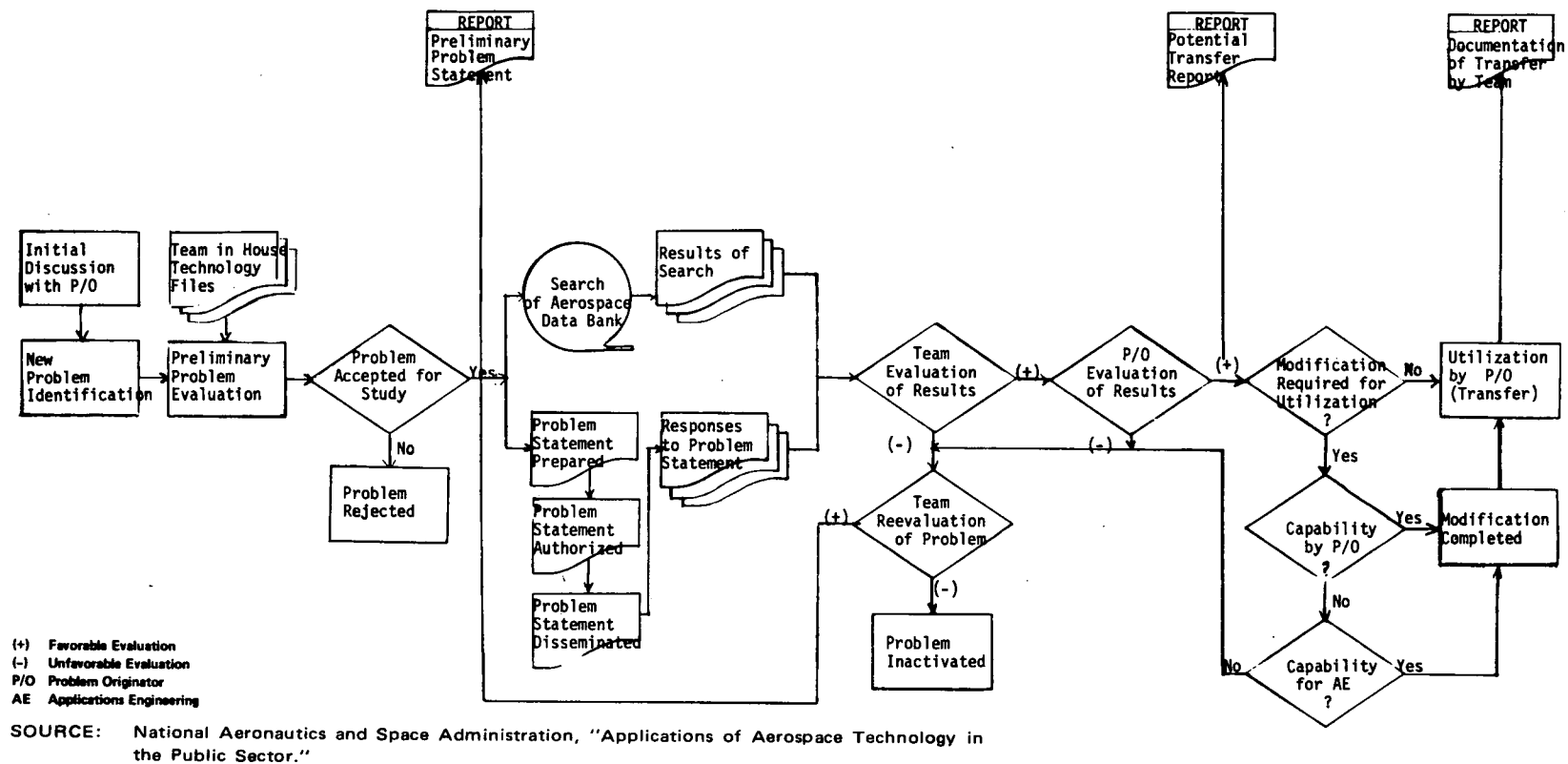
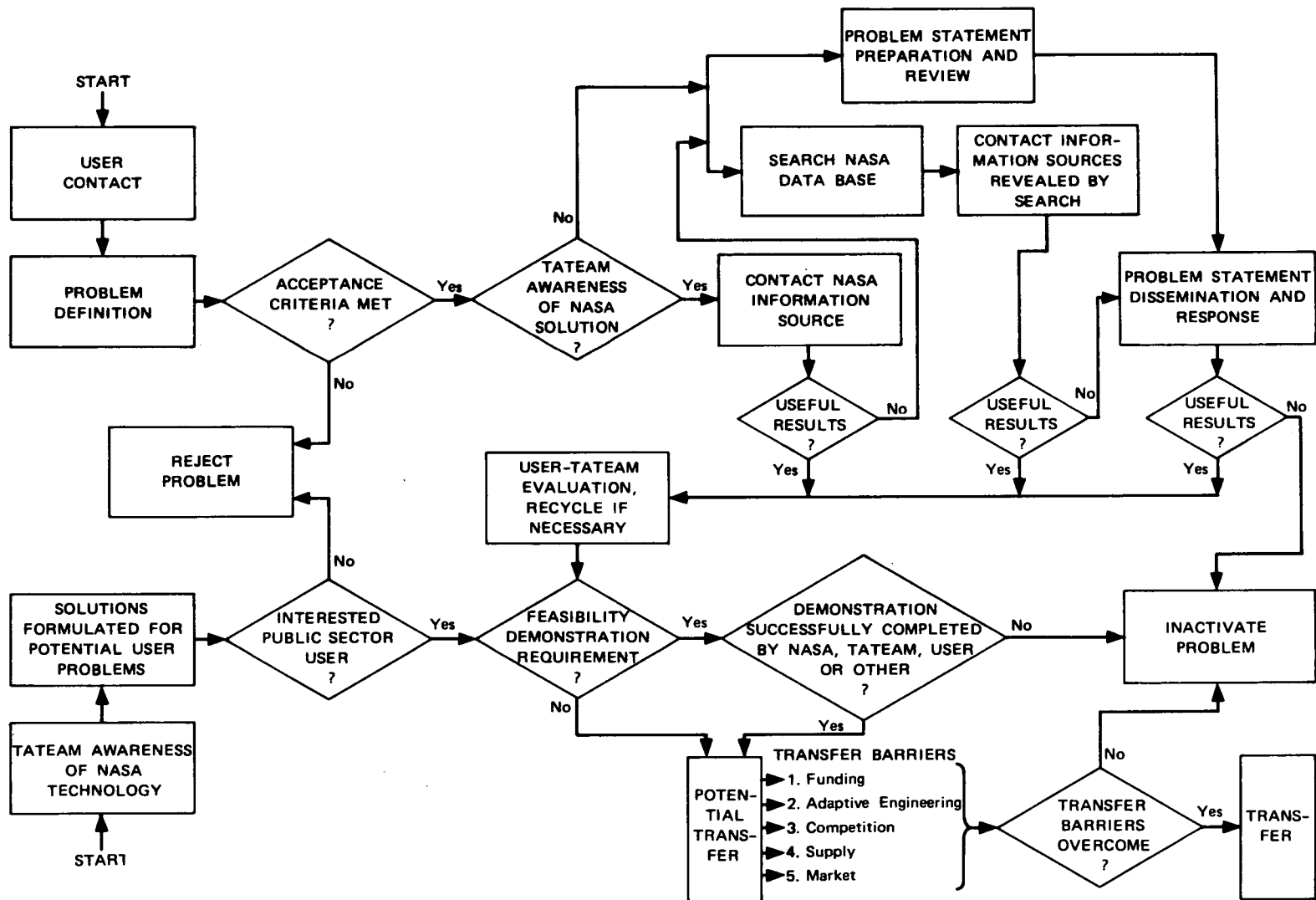


FIGURE 1 FLOW CHART OF BASIC APPLICATIONS TEAM METHODOLOGY

During the second year, two types of solution identification schemes developed. One still utilizes a modified search system for potential solutions while the other matches solutions to user problems that have not been formally expressed. These two schemes are shown in Figure 2.

When a problem and its supporting background material have been collected, a preliminary manual search is performed by the Team member, through the Tech Brief Index, the recent issues of STAR, International Aerospace Abstracts, and NASA-SCAN (Selected Current Awareness Notices), and other indexing tools. The Team is now familiar with some of the available technology, the recently reported work, and, more importantly, a series of key-word descriptors in the language of the aerospace community. A second complementary task is to present the preliminary problem to selected individuals in the NASA scientific community for additional information on unpublished material, ideas, and personal expertise and interest. Several aids in this task are lists of authors of material found in the preliminary manual search, the Research and Technology Program Flash Index, which contains a listing by title of each work unit involving advanced or supporting research active in a NASA fiscal year program, and the Program Digest Flash Index, which gives a listing of the centers and their areas of expertise, as well as one by subject with the centers working in that area.

This preliminary work may take from a day to a week or more to complete, depending on the extent of the technology which might emerge. These preliminary efforts provide the Team with a basis for formulating a search strategy that is extremely efficient and which will retrieve a high percentage of available relevant material. These preliminary efforts, when joined with the additional help from the appropriate NASA scientist who is thinking in a positive manner about the problem very early in the process, substantially advance the prospects for successful technology transfer, as compared to the more primitive and impersonal methodologies

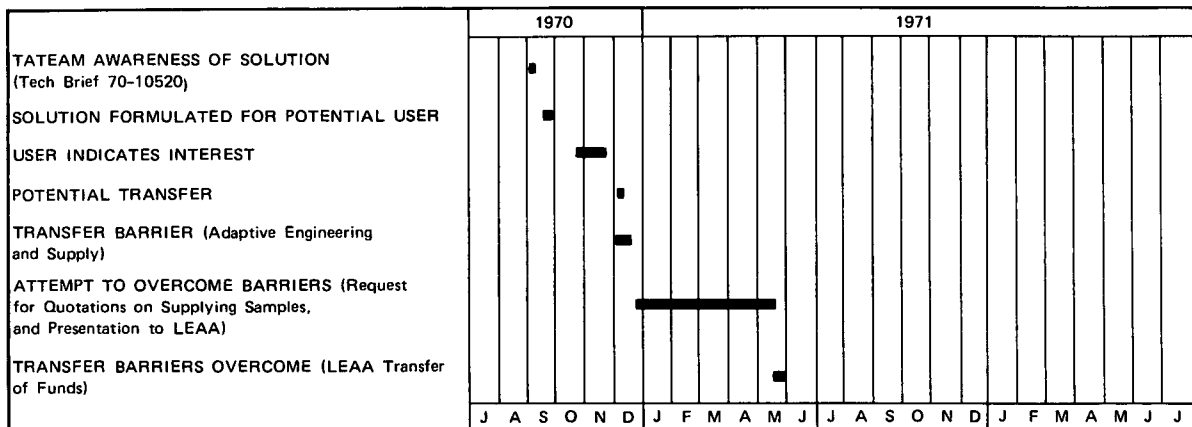


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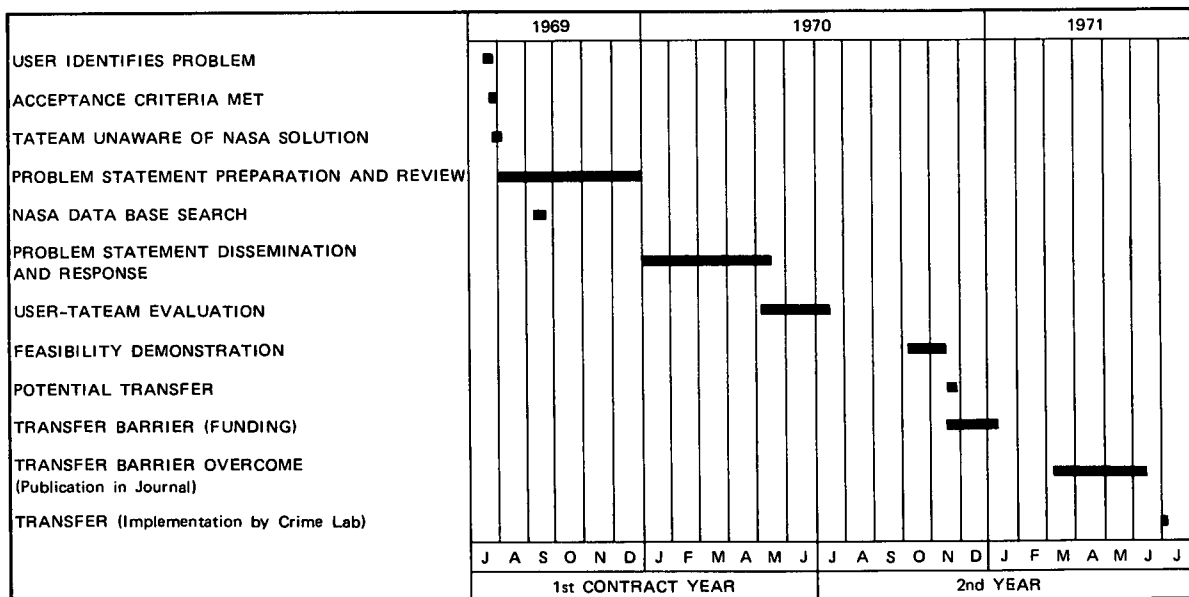
FIGURE 2 SRI/TATEAM METHODOLOGY

described previously. The information on the printout produced by the search is then evaluated by the Team and user representatives, and the information of interest is presented as a potential application. An example of this approach as it applies to a criminalistics problem is depicted in Figure 3a.

In the second scheme, the Team relies on its familiarity with the user and his concerns. This is graphically illustrated in Figure 3b which relates to a metal analysis system. In this case the Team, during a manual search of the Tech Briefs, identified the metal detector system and associated it with government building and airport security--areas of vital interest to users of criminalistics and transportation. This second scheme may be considered more desirable in that the Team approaches a user with a piece of technology that is relevant and could be of immediate use.



(a) C-22 SIMPLE METHOD OF ANALYSIS OF METALS AND METAL PRODUCTS



(b) C-1 REFLECTANCE SPECTRA/SMALL SAMPLES

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FIGURE 3 TWO SRI TATEAM PROBLEM APPROACHES

E. Transfers and Adaptive Engineering

In the transfer process, let us define three types of transfers: first-, second-, and third-order.

In a first-order transfer, the user and the developer of the technology share common disciplines and common problems. This is generally the case with the BAT effort where NASA doctors and biomedical researchers are concerned with the same human factors as doctors and biomedical researchers in the civilian sector. Technology in a first-order transfer can be transferred by a passive program and usually requires only a small amount of help from a third party catalyst. The user and developer of the technology use the same technical language, read and publish in the same journals, and attend the same meetings. In a first-order transfer, technology is generally transferred in an efficient and timely manner.

In a second-order transfer, the user and the developer of the technology share the same disciplines but not the same problems. For instance, certain new laboratory procedures for analyzing moon rocks may be adapted to trace elemental analysis of physical evidence. This new procedure may increase the precision of the measurement and thus add to the credibility of testimony. In many cases of second-order transfers, a catalytic agent is necessary to relate new techniques in NASA to the needs of the user. Although users and developers may read the same journals, this new technology is often addressed to a problem so unlike those of the user that the article goes unnoticed. It is the mission of the transfer agent to actively match the technology with the problem; only then will the user see the connection of the discipline to his problem, and adapt and use the material.

Time is important for rapid adaptation because technology must be matched to a problem at the peak of necessity. The user must have

confidence that the technology presented by the transfer agent is relevant, ready to use, and beneficial in terms of safety or savings of funds or time.

In a third-order transfer, the user and the developer of the technology do not share common disciplines or common problems. For example, a NASA electronics engineer working on an eddy current device for measuring foam insulation thickness on a Saturn rocket publishes information on the device in a Tech Brief. A member of the TATeam, interacting with the electronics engineer, sees this device as a useful tool for nondestructively measuring the thickness of concrete pavement, a problem clearly in the realm of civil engineers who work with a different set of problems and disciplines. Here a transfer agent, or TATeam member, is instrumental in matching the technology to the problem, assessing the feasibility of the technology, presenting this to the user, and assisting in the performance of any adaptive research or engineering needed for actual application.

It is obvious that the difficulty in effecting a transfer increases as the order ascends. The SRI Team's experience indicates that the operating philosophy depicted in Figure 1 does not lend itself to optimizing fully the search for second- or third-order transfers. This method depends on the formality of the Problem Statement preparation, the literature search, and the frequently random or uncertain circulation of the Problem Statements throughout the NASA community. This method is generally most efficient for first-order transfers. Users are often aware of the technology through their own information search services or their use of various documentation and information facilities. For example, the Highway Research Board Information Services (HRIS) routinely screen all technology for directly related work. This screening covers work performed or contracted by NASA, the Department of Defense, and the

Atomic Energy Commission, as well as all domestic and foreign publications and all ongoing research programs of interest to HRB.

The SRI TATeam has found that the two schemes presented in Figure 2 lend themselves to second- and third-order transfers, where adaptive engineering or adaptive research is necessary before a complete transfer can take place. Failure to recognize the necessity for this adaptive work will reduce the impact of the Team's efforts and the amount of technology applied to new fields. Adaptive research differs from adaptive engineering in that it is generally required in second-order transfers to show the feasibility and applicability of a NASA technique to a public sector problem. This may be seen in the description of events leading to the publication of the paint chip analysis method in the users' journal (Section II-A). This experience again confirms our belief that personal interaction among all of the concerned parties greatly facilitates rapid realization of a transfer. NASA scientists and engineers often interact by giving their own time and effort to show feasibility or applicability of the technology. The adaptive effort given need only be enough to convince the user, who may be somewhat skeptical, that the technology is sound and the application feasible. In many cases, the user will follow up with a more detailed study of the technology, and a transfer is near.

In third-order transfers, the problem is compounded by the need to construct prototypes for feasibility testing. Here, the NASA staff is willing to do the work but cannot give the necessary time to large efforts outside their immediate mission areas. This work may be accomplished through special NASA authorizations arising from its technology transfer mandate; however, paperwork delays may result in the loss of an important opportunity to fulfill a user's need.

Most of the problems associated with locating potential technology have been solved with the current SRI operating methodology. The SRI

TATeam recognizes that its major function in the future lies in the actual conversion from a "potential transfer" to a "transfer." A single flow chart cannot show the complex and timely set of events that must be triggered to bring about a transfer. Attitudes must be changed, funds obtained, competitive solutions evaluated, adaptive engineering and research undertaken, suppliers found, and the market evaluated.

It may become apparent from the above discussion that the private sector must ultimately become involved in most cases of technology transfer to accrue to the public sector. The market must frequently and necessarily be the indicator of the real impact of the technology involved. The TATeam activity often anticipates that the interest of one public sector agency in a particular piece of NASA technology is relied upon to cause a private sector supplier to convert that technology into a usable product. This is understandable when the public sector agency constitutes a major portion of the potential market for that product. When the market for a particular product is apparently broader than one public sector user, however, knowledge of this broader potential market, together with knowledge of the technical and economic aspects of converting the technology into a useful product, should be very beneficial in encouraging a supplier to consider the technology. Knowing the greater potential of the technology, revealed by a technical-economic market study, would cause suppliers to act quickly to outdistance the competition. These market pressures would be expected to result in attendant benefits to the public.

The SRI TATeam, in continuing close coordination with the NASA Technology Utilization Office and the other NASA-sponsored TATeams, plans to pursue these new lines of approach as integral to its ongoing interest in optimizing the technology transfer process.

ILLUSTRATIONS SIGNIFICANT TO TEXT MATERIAL
HAVE BEEN REPRODUCED USING A DIFFERENT
PRINTING TECHNIQUE AND MAY APPEAR AGAIN IN
THE BACK OF THIS PUBLICATION

II ACCOMPLISHMENTS OF THE SRI TECHNOLOGY APPLICATIONS TEAM DURING THE REPORTING PERIOD

A. Paint Chip Analysis

Criminalists often need to identify an automobile from a small amount of paint scraped at the scene of a crime. This need occurs generally in hit-and-run accidents where paint chips are recovered near the victim. Sometimes several square centimeters of paint are recovered, sometimes only a millimeter or so. Current laboratory procedure (Figure 4-a) calls for visual comparison of the evidence with sets of standard paints supplied by car manufacturers, using a binocular microscope.

An improved procedure was suggested by Dr. Fred Paul of Goddard Space Flight Center (Figure 4-b), as follows:

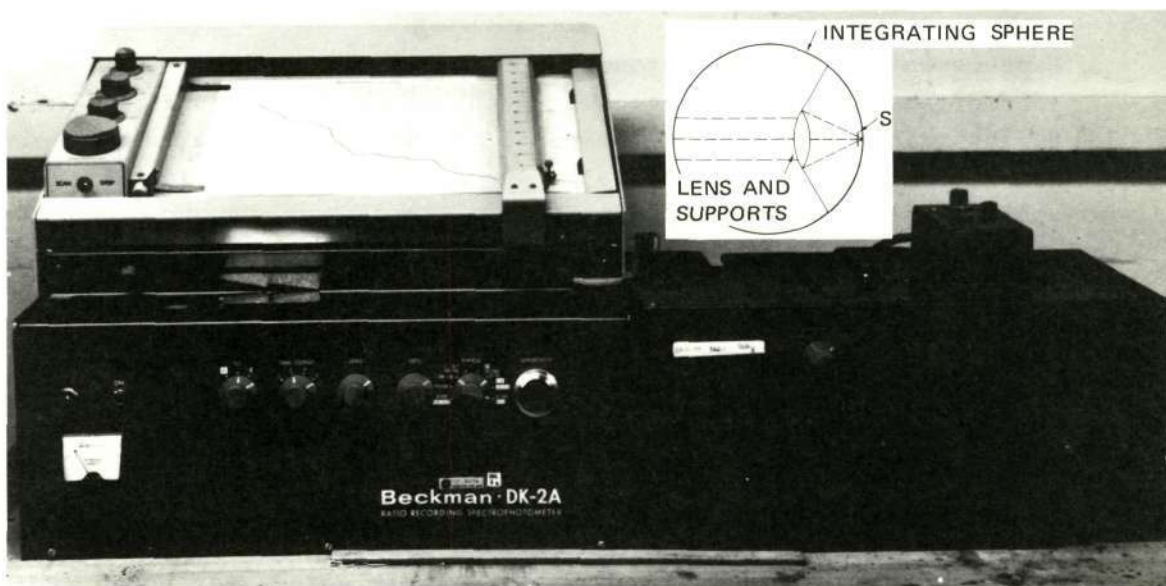
"Measurement of the reflectance spectrum of small samples can be accomplished in spectrophotometers which use an integrating sphere by inserting, in place of the usual sample, a plate carrying a standard microscope objective at the focal point at which the small sample to be measured is placed.

"The microscope objective serves to convey the illuminating beam to the sample and to return the reflected light to the integrating sphere. For the smallest sample mentioned (1 mm square) a 10 x NA 0.25 objective would be satisfactory. This costs about \$25. Making a fitting for the sample port of the integrating sphere and a means of holding the small sample at the focal point of the objective is not likely to be expensive.

"The spectrophotometer with the small sample attachment would require a new photometric calibration. This can be accomplished by modifying the comparison beam or by inserting in the small sample compartment a standard of known reflectance characteristics, e.g., smoked magnesium oxide. This recalibration can be effected without changing the calibration of the unit for its normal use. That is to say, removal of the small sample attachment can return



OLD METHOD



INNOVATION

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FIGURE 4 PAINT CHIP ANALYSIS

"the instrument to its normal use condition without further adjustment. Thus, the proposed system is inexpensive, easy to calibrate, and does not have any adverse effect on the spectrophotometer to which it is attached."

The procedure was presented to the users who were enthusiastic but lacked the equipment, time, and staff to perform any evaluation of the suggestion. Finally, after a long waiting period for user evaluation, the TATeam obtained paint samples from the crime laboratories and gave them to Dr. Paul, who then demonstrated the feasibility of his suggestion. Dr. Paul examined only three samples and established the need for more adaptive research. These experiments were performed in November 1970. In February 1971, a letter was received from the County of San Mateo attesting to the value of this procedure (Figure 5).

On the basis of Dr. Paul's feasibility study, a paper was prepared and published in the Journal of Forensic Sciences. This paper should help lay the groundwork for adoption of the technique in the courtroom. (A copy appears as Appendix C-3.)

The SRI TATeam is currently working with several schools of criminology and with the Law Enforcement Assistance Administration of the Department of Justice. More comprehensive research should be done, possibly by graduate students, before a library of reflectance spectra of automotive paint chips is set up.

Based on the experience of the senior criminalist on our Team, and on conversations with the crime laboratories, we find that of the 50,000 fatalities annually, if only 0.5%, or 250 cases, were decided by unquestionable physical evidence and never brought to trial, the savings to the taxpayer would be as follows:

COUNTY OF SAN MATEO

OFFICE OF THE SHERIFF

HALL OF JUSTICE AND RECORDS • REDWOOD CITY, CALIF.

TELEPHONE 364-1811

ADDRESS ALL COMMUNICATIONS TO THE SHERIFF

EARL B. WHITMORE
SHERIFF

EUGENE E. STEWART
ASSISTANT SHERIFF - OPERATIONS

MACDONALD U. CRAIK
ASSISTANT SHERIFF - ADMINISTRATION

WILLIAM H. BLASSER
CHIEF CIVIL DEPUTY

February 8, 1971

Dr. Brian Parker
Stanford Research Institute
Menlo Park, California 94025

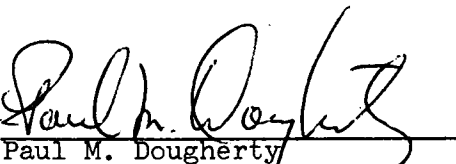
Dear Dr. Parker:

I want to thank you for your assistance in a case involving paint samples, which you rendered us. The red paints, which I submitted to you for running for their specular reflectants results were most satisfactory. It showed that the two paints involved were actually different. The reason that we like this is because we thought both of those paints were different, however, there was no real objective way to determine the difference in colors. The chart you submitted, however, shows that two paint samples are different red paints.

As this was an actual case and it helped to exonerate an individual, we wish to extend our sincere thanks and appreciation for your assistance in this matter.

Sincerely,

Earl B. Whitmore, Sheriff

by 
Paul M. Dougherty
Criminalist

PMD:hk

FIGURE 5 LETTER OF APPRECIATION

	<u>No Physical Evidence</u>	<u>Physical Evidence</u>
Laboratory costs	0	1/2 man day
Investigations	3 man days	3 man days
Legal costs	2 man days	1/2 man day
Trial costs (20 people/day, 5 day average)	<u>100 man days</u>	<u>0</u>
	105 man days	4 man days

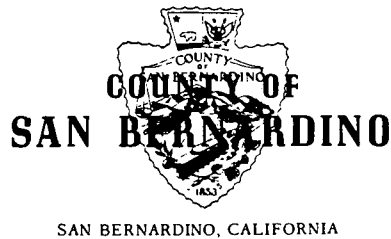
Savings: 101 man days/case at \$5/hr = \$4040/case (assuming 0.5% of 50,000 fatalities come to trial) = \$1,000,000/yr.

In addition, there are more than 1,000,000 injury accidents without fatalities. Many of these also require criminal investigations in which similar savings per case are possible. Also, most fatality and serious-injury accidents give rise to civil damage suits. Correct identification of the tort-feasor will bring about a judgment that averages \$100,000 in fatality cases and a proportionate amount in injury cases. Thus, the value estimate given in the table is very conservative.

A short time ago, we received a letter from the County of San Bernardino (Figure 6) indicating that they were adapting a spectrophotometer to incorporate this new technique. We will maintain close contact with this crime laboratory to fully evaluate and document the application and impact of this NASA technology.

B. Morphine Analysis in Urine Samples

Mr. Ronald J. Philips of NASA's Technology Utilitization Office contacted Ames Research Center and asked them to consider the problem conveyed to him by the office of the Mayor of New York City of analyzing morphine-containing urine from suspected heroin users. Urine samples are collected and are analyzed by private laboratories. Although the analysis requires only three hours, these laboratories, due to excessive work loads, cannot return the results in less than three days from sampling.



FRANK BLAND, Sheriff

First Floor, Courthouse
San Bernardino, California

TUrn 9-0111

Saturdays, Sundays & Holidays
Phone TUrn 4-6836

Crime Laboratory

July 2, 1971

Joseph G. Berke, Director
NASA Technology Applications Team
Stanford Research Institute
Menlo Park, California 94025

Dear Mr. Berke:

Re: Technology Applications Team - Criminalistics

The newsletters and special reports received from your Technology Applications Team have been circulated throughout our Laboratory to each member of the Criminalistics staff. Procedures of potential value are discussed at our regular Laboratory staff meetings.

The method of adapting the UV - visible spectrophotometer for measuring the reflectance spectra of paint samples has evoked enough interest so that we are proceeding with the necessary adaptation of our instrument. We also felt that, with enough time allowed for pre-testing, the Complex Coordinator should prove useful as a measuring tool for testing the impairment of driving ability by alcohol and/or drugs.

I'm pleased to hear that you will be continuing this effort during the coming year. You might give some thought to the possibility of holding a SRI-sponsored Seminar, primarily for Criminalistics Laboratory Directors, in which the main topic would be an evaluation of future instrumentation requirements.

Very truly yours,

Anthony Longhetti
Laboratory Director

AL:gs

FIGURE 6 LETTER OF APPRECIATION

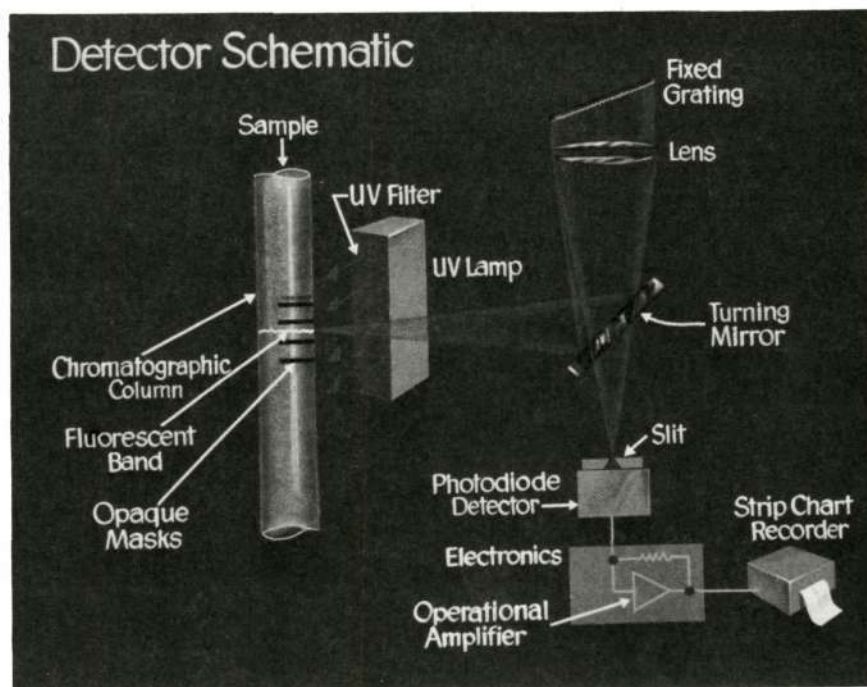
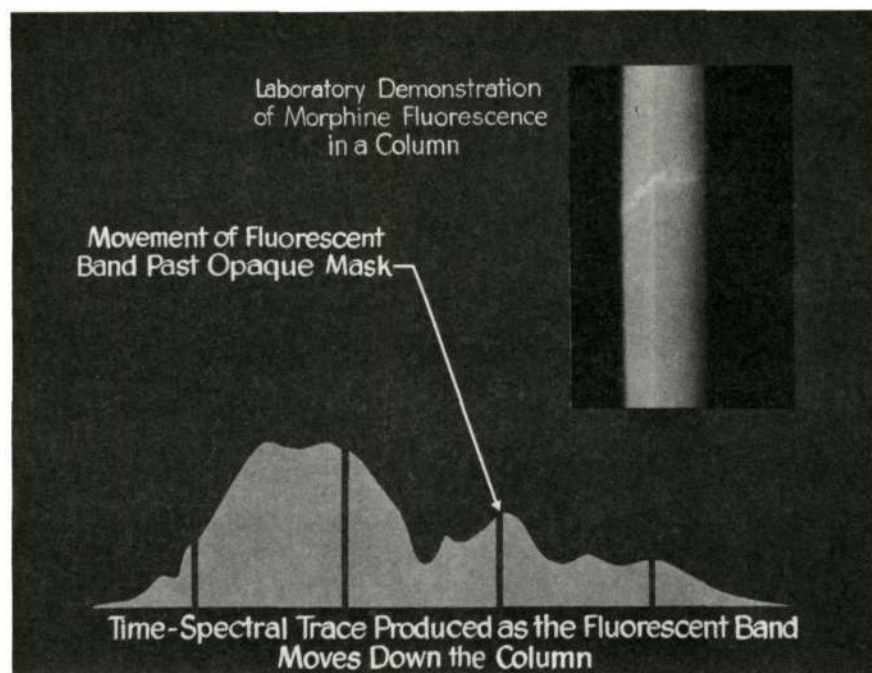
For legal or practical reasons, the suspects cannot be held for that length of time and are often released before the analytical results are received. The question posed is: Can the analysis be accelerated and still meet evidential requirements?

The Chemical Research Projects Office at Ames, under the direction of Dr. John Parker, took up the challenge and developed a system, still in the prototype stage, to perform the required analysis. This system, the Ames Chromatographic Column Drug Detector (Figures 7a and 7b), is a simple self-scanning spectrofluorometer that is proposed for use with column chromatography in the detection and identification of morphine* in the urine. Chemical treatment of a urine specimen converts weakly fluorescent morphine to a highly fluorescent fluorophore. The compound is then introduced to the chromatographic column; the morphine moves as a band down the column under standardized column conditions.

The column is irradiated with monochromatic ultraviolet radiation. If morphine is present, the morphine band emits fluorescent radiation. In this optical arrangement, the fluorescent band thus serves as the entrance slit of a spectrofluorometer. The fluorescent radiation from the morphine band is reflected by a diagonal mirror and passes through a collimator lens to a fixed diffraction grating. The light passes back through the lens, past the mirror, and focuses on the slit. Movement of the fluorescent band down the column produces the required spectral scan.

A photodiode detector receives the spectral radiation from the grating. Its output is amplified by a temperature-compensated electronic operational amplifier and is read on a simple strip chart recorder. The only moving part in the optical system is the fluorescent band traveling down the column. As the band moves downward, it passes a number of narrow, opaque

* Morphine is a metabolic product of heroin.



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FIGURE 7 THE AMES CHROMATOGRAPHIC COLUMN DRUG DETECTOR

masks that obscure the band's radiation, interrupting the signal. From the known distance between the masks and the chart speed of the recorder, the rate of movement of the band can be calculated accurately.

Thus, this system measures the fluorescence spectrum characteristic of morphine, the rate of movement of the band down the column (further confirming that compound), and the spectral amplitude (giving a quantitative measure of morphine present in the urine specimen), all at one time. This system would have application in the forensic and medical fields for detection of heroin and other drugs.

Successful development of this instrument could lead to an analyzer able to detect all drugs through a generic mode of molecular interactions. The SRI TATeam is continuing to work closely with Dr. Parker, by providing a liaison between Ames and the criminalistic laboratories, and to develop the instrument as a forensic and medical tool.

C. Determining the Effect of Drugs on Driving Ability

The effect of drugs on driving ability is of increasing concern. Alcohol, one of many drugs easily available, is involved in over 50 percent of the fatal automobile accidents. Amounts of this drug in the blood, sufficient for a presumption of influence over motor behavior, have been found in 41% of those fatally injured in accidents in which they were at fault.² Almost two-thirds of those individuals arrested for drinking-driving offenses or involved in fatal accidents or both have records of previous violations, usually involving the drug alcohol. Other drugs are commonly found in the drinking driver.³ Close to 25% of the sample cases had taken a second drug; half of those taking a second drug were mixing a prescription drug with alcohol. While quantitative information exists on the effects of alcohol on motor behavior, similar information on the effects of other drugs or combinations of drugs has not been measured

extensively. Moreover, the effect of a drug or drug combination should be capable of simple demonstration to the individual driver. A test of a few minutes duration is needed that would warn a driver of significant impairment to his performance.

One satisfactory solution is the LRC Complex Coordinator from Langley Research Center (Figure 8). As a performance measurement device, this instrument has been used to study the effects of alcohol,⁴ and dramamine,⁵ and of antihistamines.⁶ The Coordinator was used in a demonstration of the effects of alcohol on human performance for the California Driver Education Association.⁷ (See Section III, Additional TATeam Activities.) These instructors were delighted with this instrument and considered it a highly promising method for demonstrating adverse effects of drugs, fatigue, and other psychophysiological changes in the human body.

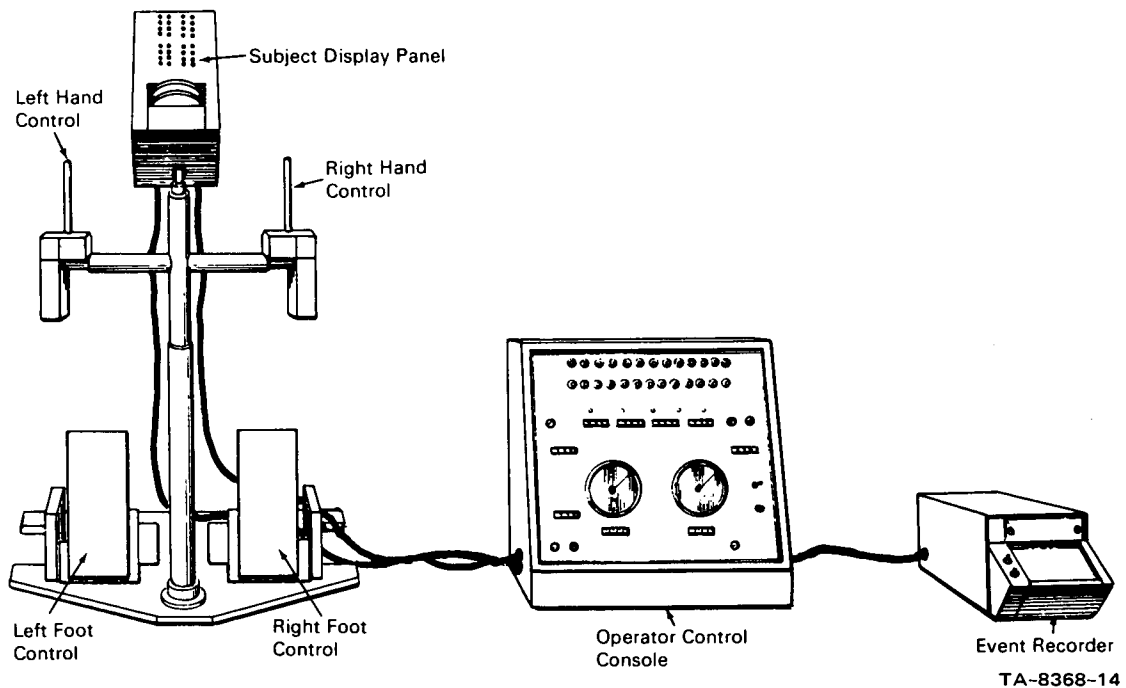


FIGURE 8 GENERAL ARRANGEMENT OF THE COMPLEX COORDINATOR

A number of other uses for the Complex Coordinator are proposed. As a rehabilitation tool, the instrument would serve as an exercise device to develop psychomotor activity, to improve coordination, or simply to measure a patient's progress. Another use would be for determining any mental disorders associated with the human motor activity. In this connection, it would be useful in testing school children, because the device has the appearance of a toy rather than of an austere piece of laboratory equipment. A third use would be to determine the effects of noise and pollution on a person's ability to concentrate and hence on his work performance.

A letter from the Orange County Crime Laboratory in California indicates that the information on the Complex Coordinator "was the original spark for a comprehensive study involving drugs and human performance, especially driving." The study, in the planning stages, has thus far involved the University of California's Departments of Pharmacology and Psychiatry in Los Angeles and Irvine, the Sheriff's and Coroner's Offices in Orange County, and other governmental agencies across the country.

The SRI TATeam is continuing to pursue the transfer of this Coordinator. Part of the effort is to collect as many suggestions for modifications as would be required by the various interested groups, to develop a product plan and a marketing plan, and perhaps to arrange for the construction of the units. The Coordinator is also being considered as a potential product for a minority small business enterprise in conjunction with the NASA-NPAED (the National Progressive Alliance for Economic Development) program.

D. Metal Detector System

This piece of technology was uncovered during a manual search of the Tech Brief Index. Once again the TATeam's familiarity with the user's

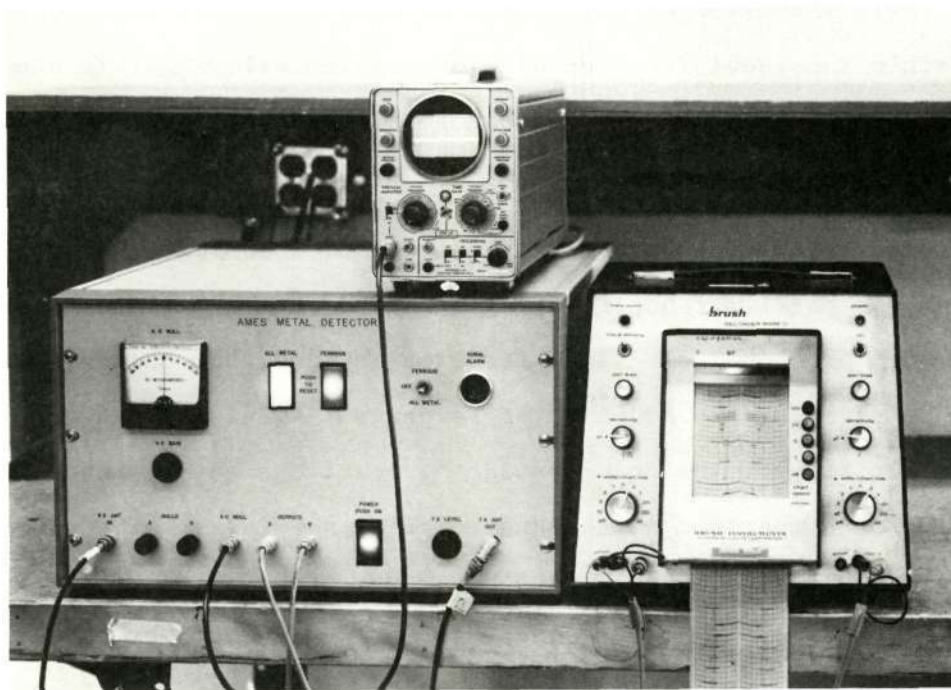
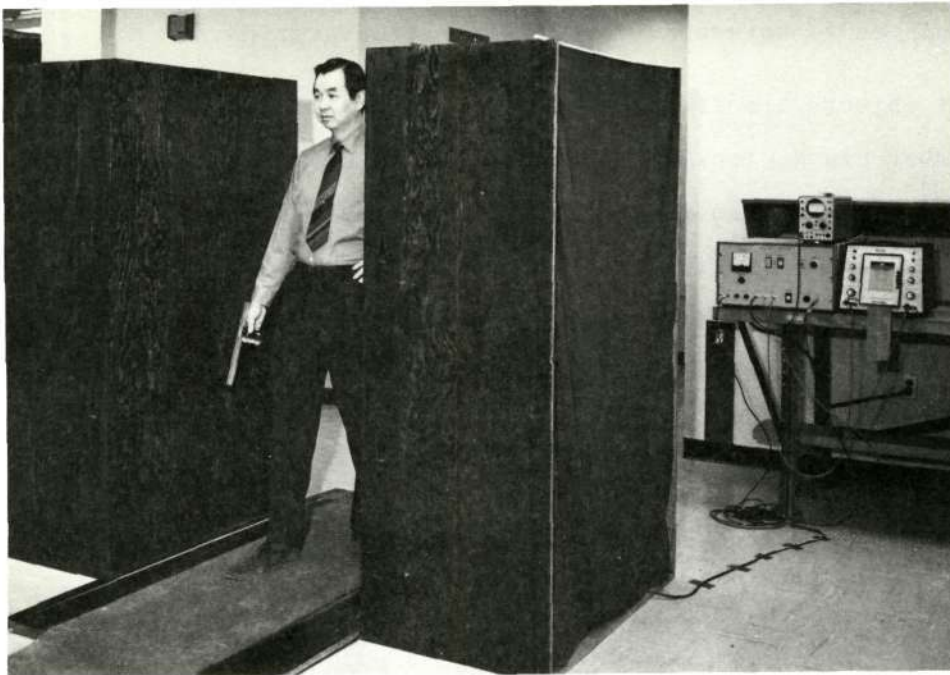
problems made possible the match. The technology was presented to the user prior to any Problem Statement formulation .

This metal detector system, TB-70-10511, developed at Ames Research Center, can perform an inconspicuous search of personnel moving into areas where metallic objects, such as guns and knives, are prohibited or undesirable. The detector can be made insensitive to metal objects below a certain size (coins, watches, pens). This size sensitivity is an adjustable property of the system. The output amplitude is substantially independent of the speed at which the metal object moves through the sensors. This feature makes the system ideal for monitoring groups of people such as are found at airline loading gates, in courtrooms, and at entrances to government buildings. The system output may be signaled by colored lights, aural alarm, or chart recorder. A schematic of this system is shown in Figure 9a and b.

Interest in this device originated at the DOT Transportation Systems Center, Cambridge, Massachusetts, which desired improved security in and around airline terminals. The device was demonstrated to two representatives of DOT's top management echelon. Arrangements are now being made to transfer a prototype unit to Cambridge for more tests. If the tests prove feasible, the SRI TATeam will perform a market-product analysis to determine actual costs of producing a number of units. These units can then be field tested at various terminals. Finally, the whole system can be packaged for production by an appropriate industrial enterprise.

E. Simple Methods of Analysis for Metals and Metal Products

This piece of technology was discovered during a manual search of the Tech Brief Index. The TATeam experience in criminalistics enabled the recognition of this Tech Brief as a possible solution to a problem in crime laboratories. The solution (consisting of a scheme for chemical



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FIGURE 9 THE AMES METAL DETECTOR

spot testing) was presented to a local user for evaluation and comment. This scheme is embodied in a NASA Langley Research publication⁸ that has been circulated to several criminalistics laboratories.

Metal objects are frequent items in criminal cases, e.g., obliterated serial number plate, toolmark on lock, bomb fragments. Determination of metallic composition can facilitate other analyses as well as serve to identify the source. A spectrographic approach is not always available in crime laboratories, whereas a wet chemical approach is easily utilized. Common chemicals, either laboratory stock or easily obtainable items, should constitute the necessary reagents. The method should be rapid in most instances, with a complete analysis taking less than an hour. The metal object should be essentially undamaged.

The scheme consists of an ordered test sequence compiled to permit rapid identification of metals and alloys. Presented in flowchart form to permit rapid reduction of the number of possibilities, the sequence makes possible the identification of even complex alloys within about 30 minutes. It thus provides a reasonable alternative to identification by means of emission spectroscopy.

The tests are performed directly on the metal surface, in spotplate depressions, or on filter paper, using standard chemical reagents suitable for laboratory or shop use. Identification is made from colors or specific reactions produced by the addition of reagents. All tests are qualitative in nature, but many of the color-producing reactions may be made semi-quantitative by comparison with standard alloy specimens. The sequence may be called nondestructive, since the amount of metal destroyed is almost negligible (approximately equivalent to that removed by one stroke of a smooth file).

The procedures cover all common metallurgical elements: aluminum, copper, magnesium, nickel, and titanium alloys; and many high-temperature, stainless, high-and-low-carbon, and tool steels. Detailed instructions

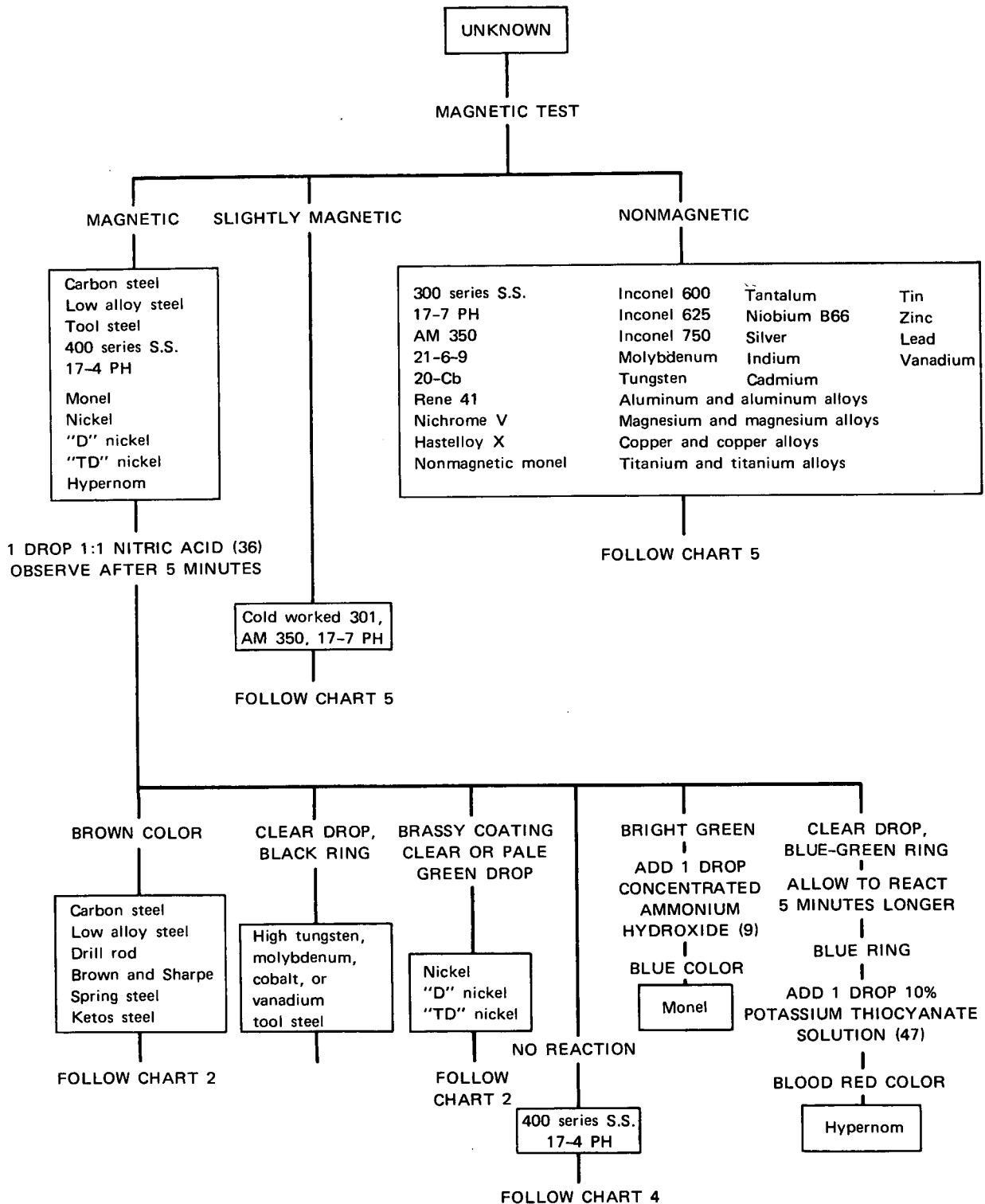
concerning the amount of each reagent used, the time to allow for reaction, and the possible results are given in the flowcharts. A sample flowchart is shown in Figure 10. Also, separate procedures are listed for confirming the presence of individual elements in an alloy.

The team is presently working with LEAA to develop and produce sample sets of the approximately 100 alloys covered by the above procedures. These specimens would be 1 to 2 inches in diameter and 1/4 to 1/2 inch thick, and would be cut from metals of certified composition. The sets would be distributed throughout the approximately 100 criminalistic laboratories for use in actual cases and to establish acceptance in the criminal justice systems.

The impact of this new technique is similar to that of the paint chip analyzer. Any cases that can be settled without court trials will result in great savings to the public and will provide the laboratories with still another tool for quick apprehension of perpetrators of crime.

F. Nondestructive Measurement of the Thickness of Portland Cement Concrete Pavements

The necessity for a nondestructive thickness measuring device is relevant to both newly constructed pavements and older ones. For new construction, the requirement is based on ensuring that specifications have been met before final payment to the contractor. For example, if the concrete thickness is reduced by 1/4 inch, a contractor could reduce his cost by approximately \$2000/mile, assuming a 40-ft-wide highway and concrete costing \$12/cubic yard. Current measurement methods require coring of the slab after the pavement has set. There are no methods available that monitor the pavement thickness as it is applied. On the interstate highway system alone, where 43,000 miles of completed highway represent 65% of the total, cores are taken every 1/4 mile, at a cost of \$30 per core. At this coring rate, it would cost about \$2.7 million for this one function



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FIGURE 10 SAMPLE FLOW CHART FOR IDENTIFICATION OF METALS (Taken From TSP 70-10520)

on the remaining 22,000 miles. The cost would be even greater if we consider all new roads to be built and maintained thereafter. In addition, a great deal of data can be rapidly collected on the wearing properties of concrete, the effects of weather conditions, the effects of various deicing chemicals, and the effects of tire wear to the pavement.

Due to the importance of this device, two projects have been sponsored by the National Cooperative Highway Research Program. The first programs in FY 64 and FY 65 were conducted with IIT Research Institute under the direction of K. E. Feith and S. D. Howkins. These programs included (1) study of all past and present methods of measuring thickness of highway pavements to determine whether any were suitable, (2) feasibility study of proposed methods then under development, (3) proposals for other feasible methods, and (4) recommendations for promising methods for development of instrumentation. A report was written covering the results.⁹

The second program, funded for FY 71, evaluated and field tested existing systems of inspection testing to determine pavement thickness and reinforced steel position at the construction site, either before or after the concrete has hardened. The purpose of this program, under way with the Pennsylvania Department of Highways, is elimination or substantial reduction of the coring process. During this testing program, the SRI TATeam and the state of Pennsylvania became aware of two NASA Tech Briefs originating at Marshall Space Flight Center.^{10,11} These Tech Briefs became the basis for the most promising device yet identified for the non-destructive measurement of pavement thickness. This is a battery-operated device to measure eddy current proximity, which was originally developed to measure the thickness of spray-on foam insulation on the NASA Saturn S-2 rocket. The device, which is similar to a metal detector, can detect a metal plate or foil laid on the base course before paving (Figure 11). The eddy current device functions by driving a coil with a radio-frequency generator, creating a magnetic field. This field produces circular and



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FIGURE 11 PAVEMENT THICKNESS MEASURING DEVICE

coaxial eddy currents in the buried conductive plate (or foil), which is separated from the coil by the thickness of the pavement. The eddy currents, in turn, cause a magnetic field in a coaxial secondary coil which is opposed to the field generated by the primary coil. The superimposition of the two fields reduces the effective inductance of the secondary coil, causing a measurable change in the magnitude and phase of the current flowing in the coil. The foil can be of any inexpensive metal, 12 to 18 inches square with a minimum thickness of 0.02 mil. The instrument can be tuned to discriminate between the reinforcing rods and the base plate and can determine the thickness of slabs up to 15 ± 0.10 inches. Due to technical considerations, however, it cannot be used to measure the thickness of pavement reinforced by steel mesh (rather than steel rods) although it can determine the depth of the mesh in the pavement.

Based on the tests conducted by the State of Pennsylvania,¹² the instrument did appear to offer more potential than any other device in the project. It was recommended for inclusion in Phase II of NCHRP Project 10-8, wherein instruments are used on actual highway construction projects in several different states.

If the field tests are successful, the device will be ready for commercial production. Mr. Robert L. Brown of Marshall Space Flight Center estimates a commercial cost of about \$500 per unit, 6 to 8 times less than that of other available units. At this price, all the states would be able to obtain suitable quantities for quality control of highway construction and maintenance for a savings in dollars and increased safety.

G. Nondestructive Testing of Large Metal Structures

Many suggestions were made for the solution of this problem of testing bridges for signs of fatigue or cracking. From these, three were chosen to be pursued in greater detail.

1. Mircrowave Radiometer

Mr. Ronald J. Hruby of the NASA-Ames Research Center has proposed one of the more promising solutions. It requires a microwave radiometer for locating suspect areas in bridges, keeping in mind that the problem is to locate suspect areas in large steel structures rather than to pinpoint the defect. Pinpointing and determining the exact nature of the abnormality (cracks, corrosion, strained or fatigued metal) can be determined by close examination of the suspect area with conventional NDT equipment, such as radiographics, ultrasonics, eddy current, penetrants, and so forth. Additional research is being done on the feasibility of this technique.

No structure exposed to environmental conditions is in exact thermal equilibrium; that is, thermal gradients must exist in the structure. Since most brdiges have repeating geometrical patterns, each geometrical section of the bridge should have a thermal gradient pattern (isotherm) similar to the patterns of the other sections. There is experimental evidence to support the belief that a crack or corrosion will affect an area of the thermal pattern many times its own size. The bridge would be scanned with a microwave radiometer mounted in a small aircraft flying 100 to 200 ft from the bridge. A thermal imaging system would be used with the radiometer to produce a picture of the thermal pattern.

2. Acoustic Emission

It is possible with acoustic emission to predict structural failure by "listening" to stress waves emitted during the deformation of metal. Much preliminary research and development has been supported by the Atomic Energy Commission. The technique has been commercialized and instrumentation is now available.

3. Random Vibration Signatures

This technique has been used at NASA's Ames Research Center in wind tunnel studies of wing models to detect incipient damage. The technique, reported by Cole,¹³ requires monitoring the random vibration signatures in a structure. The signatures are compared with previous ones and any deviation noted. Accelerometers are used as sensors, feeding into a correlation computer. The electronic components are small, requiring only about 1-ft deep section of a normal electronics rack. According to Ames' electronic engineers, this size can be reduced further. The computer at Ames cost about \$6000, but, if commercialized, it could be priced in the \$2000 to \$3000 range. Some developmental work is needed to determine if the concept is applicable to bridges. Signatures need to be taken of the bridge and examined to determine the presence of the range of frequencies and the repeatability of signatures.

H. Road Repair Material

The problem of patching holes and cracks in roadways is universal, but it becomes more acute on concrete bridge decks where the roadway must be repaired quickly to avoid damage to the underlying structure and to prevent impedance to the flow of traffic. The epoxies currently in use have several limitations that justify the search for new patching materials. These include poor bonding to the concrete, differences between epoxy coefficients of expansion and those of concrete, and a very slow rate of cure at temperatures below 70° F. In addition, epoxies tend to cause skin irritation to workers after repeated contact.

The SRI TATeam, through a computerized search of the NASA data base, uncovered a thermoplastic rubberlike material (TB 66-10453) that may possess all the requirements for a concrete repair material. This material was the result of NASA research on new solid propellant rocket fuel binder conducted at the Jet Propulsion Laboratory in California. The material is

prepared by blending a copolymer of ethylene and vinyl acetate with asphalt and a petroleum distillate. The Tech Brief indicates that this new material can be easily molded or extruded and is compatible with a variety of fillers. Projected uses for this material include paving of roads, driveways, and playgrounds; roofing; swimming pool linings where a resilient surface is desirable to reduce injury, covering of sanitary landfills, and several other applications.

The Team, working with the California Institute Research Foundation, is evaluating the market potential for this item. As part of the evaluation, we will supply various highway departments with some material for road testing. Tests will be performed in very cold climates, hot climates, and environments containing salt and other chemicals that damage road surfaces. In addition, the Team is in close contact with the Highway Research Board and the Federal Highway Administration for their evaluation and assistance in testing the material on various ongoing highway research programs.

I. Tank Car Safety--Fire Protection

The Association of American Railroads (AAR), in conjunction with the Railway Progress Institute (RPI), has undertaken an extensive 2-year research program on tank car safety. A major portion of this program is concerned with finding and evaluating methods of preventing the rupture of tank cars carrying flammable fluids in a postderailment fire environment. A solution to this problem could prevent disasters such as the Crescent City fire of June 1970, which resulted from fire-induced tank car ruptures occurring minutes after a train derailment.

The SRI TATeam has found a potential solution for this problem in the laboratories of the NASA-Ames Chemical Research Projects Office. Their work is centered around developing materials to protect aircraft and aircraft

components in a fuel fire. In particular, they have developed lightweight, easy-to-apply intumescent paints and fire-retardant foams,^{14,15} which they consider to have better properties than any materials now commercially available.

The AAR has indicated that there are about 15,000 tank cars carrying flammable materials. These cars will be refitted with the best protective scheme available that can (1) keep the tank car walls below 800° F for 1/2 to 4 hours, (2) withstand the structural and weathering environment of a tank car, and (3) be installed for less than \$1,000 per car.

The AAR-RPI Tank Car Safety group is now evaluating samples of candidate materials. They have supplied the SRI TATeam with detailed specifications and with steel plates and holders for Ames to coat with their best candidate materials. They plan to move on to 1/5-scale model tests in late summer.

The people at Ames will evaluate their in-house materials with regard to the railroad specifications and then send samples to the AAR. They expect to complete this evaluation during the month of July.

A solution to this problem will save lives as well as money. In the past 15 years, there have been postderailment fires resulting in some 200 ruptured tank cars. Of these, about 40 occurred in a recent 1-year period. The lives that were lost and the multimillion dollar damage that resulted can be appreciably reduced by eliminating the tank car ruptures, which greatly extend the radius of destruction.

J. New Railroad Tie Materials

While reviewing the work being done at the NASA-Ames Chemical Research Projects Office (CRPO) laboratories in conjunction with tank car thermal protection, the SRI TATeam became aware of some exploratory work in developing high density foams. This, coupled with some knowledge of

railroad crossties gained through informal discussions with AAR personnel, led to the suggestion of using high density foams to fabricate crossties.

Wood is by far the most common material used for crossties. It has excellent material properties for this application and rail attachments can be made easily. There are some problems however: (1) the high-grade wood used for crossties is in short supply and thus is becoming more expensive (currently \approx \$7/tie), (2) wood ties have a life of about 35 years which is shorter than that of most roadbeds, and (3) there is no adequate means for disposal of the 16 million ties that must be replaced each year.

Concrete is an alternative material that is used extensively in other countries where wood is in short supply. The cost is twice that of wood; however, the life is also doubled. Concrete does not respond to train-induced loads as well as wood and is cracked by accidents, delaying repair of the roadbed.

A high density foam may be able to combine the desirable properties of wood with the longer life of concrete at a reasonable cost. Perhaps in-place repair may be possible rather than replacement. When removed, the high density foam can be recycled as an insulating material or for other applications.

The AAR has recently been asked by a member railroad to evaluate plastic ties. They are much interested in the foamed plastic concept proposed by the SRI TATeam. They have forwarded a set of specifications and are prepared to test available items, from material samples to complete ties.

Ames CRPO lab personnel, working with the NASA Headquarters Technology Utilization Office and the SRI TATeam, plan to fabricate material samples and then a large block of foam with a rail anchor bolt inserted. Later perhaps they will fabricate complete high density foam crossties.

To be competitive, a foam crosstie would have to result in material, maintenance, installation, replacement, and disposition savings.* Foam is expected to offer its greatest savings in maintenance and disposition expenses.

* Last year railroads incurred \$80 million in material costs alone for crosstie installation and replacement.

III ADDITIONAL ACTIVITIES OF THE SRI TECHNOLOGY APPLICATIONS TEAM

An obviously important ingredient of any successful transfer program is the increased visibility of the activity gained through participation in meetings and by presentation to the user community of concrete program results. The SRI TATeam has participated during the past year in the meetings described below.

A. NASA's BAT/TAT Conference

A joint conference was held in June of 1970 to discuss the philosophies and methodologies of the evolving transfer programs. At this meeting, the SRI team and other teams achieved a high level of communication and interaction among themselves. The meeting demonstrated the importance of putting interteam cooperation on a more personal basis and has resulted in increased efficiency and useful synergisms among several interrelated technology utilization projects.

B. Wincon '71

Dr. Charles J. Cook, the SRI program supervisor, was invited to present a paper at the 1971 Winter Convention on Aerospace and Electronic Systems, held in Los Angeles during February 1971. Dr. Cook's paper is given in Appendix C.

C. Air Force Association Convention

An invitation was extended to and accepted by Dr. Cook to present a paper on technology transfer at the Air Force Association Convention in Pasadena, California on March 27, 1971.

D. NASA-ICMA Meetings

The SRI TATeam, with emphasis on its mission areas in criminalistics and transportation, is currently participating in the NASA-ICMA (International City Management Association) joint program to apply aerospace technology to pressing urban problems. The TATeam participated in regional meetings in Los Angeles and Washington, D.C. to assist in developing a set of urban problem statements. The SRI TATeam was able to relate some of the ICMA problem areas to some current problems presented to team members by other user agencies. Increased activity is anticipated in this area of urban problems, and the Team is continuing to participate on an accelerated basis.

E. California Driver Education Association (CALDEA)
1971 Annual Convention

The SRI TATeam was invited to participate, along with the Santa Clara County Department of Criminalistics, in a demonstration of the role of alcohol in the impairment of motor skills. The TATeam explained and demonstrated the NASA Langley Research Center complex coordinator* at the March 26, 1971 CALDEA meeting held at San Mateo, California (Figure 12). A paper compiling the results of the demonstration has been prepared for submission to a relevant user journal. The paper as well as two newspaper accounts of the demonstration are presented in Appendix C.

F. Citrus Belt Driver Education Association Meeting

A demonstration on the effects of alcohol, similar to the one for CALDEA, was held on May 10, 1971 at Redlands, California with the cooperation of the San Bernardino County Criminalistic Laboratory (Figure 13).

* See Section II-C.



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FIGURE 12 CALIFORNIA DRIVER EDUCATION ASSOCIATION ANNUAL MEETING



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FIGURE 13 CITRUS BELT DRIVER EDUCATION MEETING

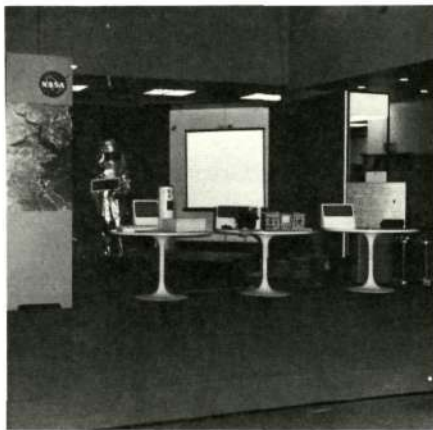
Dr. Grady V. Maraman and Dr. Redford Saucer, of NASA's Langley Research Center, presented a short talk on their activities using the complex coordinator in laboratory tests. Considerable interest was shown in adapting a simpler version of the coordinator to a classroom situation as an additional aid in driver education.

G. San Mateo Kiwanis Club Meeting

Dr. Brian Parker of SRI's Technology Applications Team addressed the Kiwanis Club luncheon meeting in San Mateo, California on April 29, 1971. The talk was titled, "How The NASA Information Developed Can Be Used to Everyone's Advantage."

H. Urban Technology Conference

Members of the SRI TATeam participated in the first annual Urban Technology Conference in New York City in May of 1971. Participation included demonstration of potential applications of aerospace technology to urban problems. SRI's team demonstrated the pavement thickness measuring device, the complex coordinator, and the drug detector system, in addition to assisting in presentations on the other aspects of the NASA Technology Utilization Program. Some of the conference exhibits are shown in Figure 14.



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FIGURE 14 NASA EXHIBITS AT URBAN TECHNOLOGY CONFERENCE

IV CONCLUSIONS AND RECOMMENDATIONS

The transfer of technology has four major elements: user participation, problem identification, search, and application. Much of the available technology lies in areas requiring second- and third-order transfers. The data, processes, techniques, and other elements which combine to make up NASA's technology resources must be identified and made visible and viable for a transfer to occur.

To maximize the visibility and viability of new technology, a third-party transfer agent (a technological catalyst or entrepreneur) is required. This third party bridges the gap between user and technology developer, particularly when the problems and disciplines are very different, as is usually the case. Small or nontechnical firms in particular, must have their problems translated into the terms which permit the technology available for their solution to be identified.

The classical problem statement, search, and dissemination-and-reply steps of Figure 1 normally do not lend themselves to the efficient identification of solutions and their timely application to the users' needs. The methodology of Figure 2 and the increased personal interaction with the developers of the technology--in this case the NASA community--provide a mechanism whereby both user and the developer may participate to a greater and more useful extent.

Once a piece of technology is identified, the problem of adapting it to a new area arises. Our experience indicates that public sector agencies usually lack the mechanisms necessary to divert time and funds to an untried piece of technology, and that the obligation for showing relevance or feasibility lies with the originating laboratory or sponsoring

agency. For example, both the paint chip analysis technique and the metal detector system were demonstrated by the NASA centers to be relevant and feasible. After feasibility was demonstrated, the users were able to justify expenditures of time and money for the additional work needed before the technology could be fully implemented.

The application of any new technology is generally within the business context of manufacturing, marketing, sales, and distribution. Efforts in this middle area between technology development and public use must be one of the transfer agent's primary activities. These activities must be administered in a manner that will develop requirements for new markets and suppliers for these markets, almost concurrently with the feasibility and adaptive engineering studies. With this method of operation, any technological changes required by the market can be readily incorporated. It is important to note that public sector agencies depend on their contractors and suppliers for new technological advances. For this reason, the injection of new technology alone may not result in a transfer.

Finally, the characteristics of an ideal user agency or subgroup within that agency must be determined. Large agencies with many technological problems may be constrained by operational procedures, funding limitations, excessive work loads, or a conservative bureaucratic hierarchy that discourages active participation in the transfer process. It is important also to determine the qualities of "in-house champions" of the program. Will they be able to get a management commitment for acceptance and implementation of any new technological solutions to their agency's problems? This study might be carried out as an addition to a particular TATeam effort and should be addressed to the particular team's user areas (e.g., an ideal criminalistic user may possess different qualities from those of an urban construction user, as well as a completely different set of operational procedures). The knowledge gained to date

concerning the value of technology transfer strongly suggests that a concerted promotion of the transfer concept by both government and industry be undertaken. Technology transfer is a valuable new asset to the free enterprise system. However, the full benefits which technology transfer can bring to the economy can never be known until government, industry, and other sectors of our society take a more active and interested role in a complete technology transfer program.

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Appendix A

AGENCIES CURRENTLY UTILIZING THE SERVICES OF THE SRI TATEAM

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Appendix A

AGENCIES CURRENTLY UTILIZING THE SERVICES OF THE SRI TATEAM

Alameda County Sheriff's Office, Pleasanton, California
Alaska Medical Laboratories, Anchorage, Alaska
American Academy of Forensic Sciences, Washington, D.C.
Association of American Railroads, Washington, D.C. and Chicago, Illinois
Boston Police Department, Boston, Massachusetts
California Division of Bay Toll Crossings, San Francisco, California
California Division of Highways, Sacramento, California
California Driver Education Association, Foster City, California
California Medical Facility, Department of Corrections, Vacaville, California
California State College at Los Angeles, Los Angeles, California
California State College at Long Beach, Long Beach, California
Center for Urban Regionalism, Kent University, Kent, Ohio
Contra Costa County Office of the Sheriff-Coroner, Martinez, California
Criminal Identification and Investigation Bureau, Sacramento, California
Dade County Public Safety, Miami, Florida
Fairbank Highway Research Station, Federal Highway Administration,
Washington, D.C.
Federal Railroad Administration, Washington, D.C.
Florida Department of Law Enforcement, Tallahassee, Florida
Highway Research Board, Washington, D.C.
Highway Safety Research Center, Chapel Hill, North Carolina
Highway Safety Research Institute, Ann Arbor, Michigan
Illinois State Crime Laboratory, Joliet, Illinois
Institute of Traffic and Transportation Engineering, Richmond, California
and Los Angeles, California
International Association of Chiefs of Police, Washington, D.C.
John Jay College of Criminal Justice, New York, New York
Kern County Sheriff's Office, Bakersfield, California
Long Beach Police Department, Long Beach, California

Los Angeles County, Department of the Chief Medical Examiner-Coroner,
Los Angeles, California

Los Angeles County Sheriff's Office, Los Angeles, California

Los Angeles Police Department, Scientific Investigations Division,
Los Angeles, California

Marin County Sheriff's Office, San Rafael, California

Miami Valley Regional Crime Laboratory, Dayton, Ohio

Montana Highway Commission, Helena, Montana

National Highway Traffic Safety Administration, Washington, D.C.

Oakland Police Department, Criminalistics Section, Oakland, California

Ohio Highway Transportation Research Center, East Liberty, Ohio

Orange County Coroner's Office, Orange, California

Orange County Sheriff's Office, Santa Ana, California

Pennsylvania Department of Transportation, Harrisburg, Pennsylvania

Phoenix Police Department, Phoenix, Arizona

Riverside County Sheriff's Office, Riverside, California

Sacramento County Coroner's Office, Sacramento, California

Sacramento County Office of the District Attorney, Sacramento, California

Sacramento State College, Sacramento, California

San Bernardino County Sheriff's Office, San Bernardino, California

San Diego Police Department, San Diego, California

San Francisco Coroner's Office, San Francisco, California

San Francisco Police Department, San Francisco, California

San Jose Departments of Public Works and Traffic Engineering, San Jose,
California

San Mateo County Sheriff's Office, Redwood City, California

Santa Clara County, Laboratory of Criminalistics, San Jose, California

Seattle Police Department, Seattle, Washington

Southern California Rapid Transit District, Los Angeles, California

Transportation Systems Center, Cambridge, Massachusetts

U.S. Department of Transportation, Washington, D.C.

U.S. Postal Service, Washington, D.C.

University of Illinois, Criminal Justice Curriculum, Chicago, Illinois

Walter Reed Army Institute of Research, Washington, D.C.

Washington Metropolitan Police Department, Washington, D.C.

Washington State, Department of Highways, Olympia, Washington

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Appendix B

DESCRIPTIONS OF CURRENT PROBLEMS

Appendix B

DESCRIPTIONS OF CURRENT PROBLEMS

Criminalistics

SRI/C-1 Measuring Reflection Spectra of Very Small Samples

A frequent problem in criminalistics is to identify an automobile from a small amount of paint left on an object it has scraped, especially in hit-and-run cases. Sometimes several square centimeters are left, sometimes only about a square millimeter. Identifying the paint can lead to identification of the make of car, and even the year and model sometimes.

SRI/C-2 Determining Immunological Properties in Physiological Materials

Materials are needed for identifying immunological properties (in addition to simple blood groupings) in physiological matter, particularly dried blood and blood stains. Many types of immunological classification are known for liquid blood. If these classification methods could be applied to blood stains and dried blood, detection and conviction of criminals would be aided.

SRI/C-3 Enhancing of Contrast on Questioned Documents

A nonreflective thin coating is needed to ascertain the ordering of writing at crossovers on questioned documents, when the question arises as to which of two crossing lines was written first. When liquid inks were in common use, this could be determined by the flow of ink from the later line into channels made by the passage of the earlier nib. This does not occur with the much more viscous ball point inks. For examination with a scanning electron microscope, a thin gold coating is applied, but its specular reflection makes microscopic examination very difficult. An optically dull substitute is desired.

SRI/C-4 Preserving Vaginal Swabs

Whenever a complaint is made that involves a possible prosecution for rape, a vaginal swab of the victim is secured. Experience shows that only a small fraction of the complaints develop into rape prosecutions. It would therefore be wasteful and prohibitively expensive to examine all these samples immediately. Preserving the samples at the point of origin is desired so that they can be examined when indictment is being considered--about one month.

SRI/C-5 Characterizing and Individualizing Hair

Among the most frequently found items of physical evidence are samples of hair. At present, it is not possible to establish positive identification on the basis of hair because only a broad classification can be obtained. It is desired that the possibility could be excluded that another person's hair would also match the sample.

SRI/C-8 Digitization of Fingerprints

Fingerprints are classified by a topological system (number of ridges between features) since successive prints of the same finger may vary in area covered and size. An automatic method is needed to record, classify, transmit, and retrieve fingerprints. At the present time most of this work is done manually.

SRI/C-9 Comparison and Classification of Evidence Items

An automatic comparison method is needed, not only to save time and labor, but also to create an objective record that can be introduced in evidence. This digital or analog system should be able to compare an item of physical evidence, such as a tool mark, bullet, or footprint, with a comparison item, and permit retrieval of matching items from a file.

SRI/C-10 Determining the Age of Writing in Documents

When documents were written in liquid ink, oxidative changes of the ink and reactions of its components with the cellulose and lignin of the paper permitted at least approximate dating. Ball point inks, however, are subject to very slow oxidation changes, and ink formulations include an oil-soluble or polyalcohol base, a dispersed polymer, and a dye or pigment. Information is needed that can lead to analytical methods for determining the age of such ink deposits.

SRI/C-12 Simple Analytical Methods for Drugs

There are two types of drug analysis: determination of the identity of seized samples and determination of drug levels in blood, urine, or other physiological specimens. The latter is much harder and may lead to wrongful convictions based on inferior evidence. Chemical separation procedures followed by gas chromatography, with collection of the effluents for infrared spectrophotometry or mass spectrometry, is a satisfactory method; however, most criminalistics laboratories do not have this equipment.

SRI/C-13 Effect of Drugs on Driving Ability

Illicit drugs, prescription drugs, and even some cold remedies that are sold over the counter can impair driving ability. However, law enforcement authorities have little or no quantitative information on their effects, especially as these relate to the manual skills, reaction times, and judgment factors. Such information would help obtain convictions of motorists who drive under the influence of drugs and might also, if widely disseminated, prevent people from driving dangerously.

SRI/C-14 Immobilization of Bombs

All large police forces have bomb squads to cope with bombs left by criminals. One element that is common to both crude and sophisticated bombs is an electric initiation, usually internal batteries. Dropping the bomb into lubricating oil requires moving the bomb and therefore is not considered safe. A disarming method is sought that does not involve moving the bomb.

SRI/C-15 Characterization of Glass

It is a deeply satisfying moment for an investigator when he can take a piece of glass found at the scene of a fatal hit-and-run accident and fit it precisely into the gap left in the broken headlight of the suspect's car. Unfortunately, the glass is usually shattered into fragments too small for reconstruction. Therefore, glass characteristics must be determined to compare with the known properties of glass in various makes of cars, including refractive index, elementary composition, and hardness.

SRI/C-16 Metal Detectors

Bullets, guns, keys, burglar's tools are some of the metal objects often sought during a police investigation. These may be imbedded in a wall or tree and may be ferrous or nonferrous. Metal detectors designed to detect land mines are not satisfactory for investigative purposes. Apparently specially designed detection instruments are needed.

SRI/C-18 Soil Identification and Individualization

In the commission of a crime, the perpetrator often leaves or picks up soil. Where soil from the crime scene can be correlated completely with soil found on a suspect, the first step in individualizing the

specimens is achieved. The second step is to consider the probabilities of the environmental distribution of soil constituents, including mineral matter, biological matter, and artificial matter. Since specimen quantities are frequently amounts producing a clothing smear or filling a shoe nailhole, a systematic method is needed to qualitatively and quantitatively characterize soil constituents in small samples.

SRI/C-19 Differentiating Human Beings by Sweat Analysis

The stress during a criminal violation increases the chances that human sweat will be left at the scene through contact, such as fingerprints. Clothing left at the scene is apt to bear sweat stains. Information from an analysis of sweat is needed. This might include determination of human origin by precipitin test and blood group if a secretor (80% of population). Microscopic flora and fauna would bear consideration as to qualitative distribution among individuals.

SRI/C-20 Correlation of Tool Marks by Microtopological Analyses of Striae

Many crimes require the use of tools and these often leave marks. The microscopic variations, on the order of a microinch, in a crime scene mark and those of a mark made by a suspected tool are juxtaposed with a comparison microscope by present techniques. Low-angle incident light on the marks produces a hill-and-vale rendition of the striae. These are adjusted by relative movements to align the two marks, resulting in mismatches. A technique is needed for retrieving profile information from striae produced by tools and correlating profiles from the same tool at different times.

SRI/C-21 Methods of Testing Tools for Agreement with Production Specifications

In scientific crime detection, recovered tools or broken tool parts can provide clues to perpetrators if the tools can be traced to a manufacturer or fabricator or if the manufacturing mode can be specified. Where no trademark or other identification is available, a surface finished by a grinding wheel will present surface discontinuities that can be traced. Information on materials, forming procedures, and finishing techniques obtainable from the final tool product can be a tremendous aid to criminal investigation.

SRI/C-22 Simple Methods of Analysis for Metals and Metal Products

Metal objects are frequent items in criminal cases, e.g., obliterated serial number plate, toolmark on lock, bomb fragments. Determination of metallic composition can facilitate other analyses as well as serve to identify the source. A spectrographic approach is not always available in crime laboratories, whereas a wet chemical approach is easily utilized.

SRI/C-23 Cell-Free Homogenization of Tissue

The extraction of organic poisons (and their metabolites) from biological tissue is approached by techniques such as simple diffusion, mechanical rupture, and differential solubility. Since a qualitative identification is the first step, the extent of extraction is traded off or balanced against the speed, sensitivity, and specificity of analysis. If the subsequent purification is not unduly time-consuming, an automated system to rupture all cells in a single specimen would reduce the time necessary for operator attention and yield a more complete extraction.

SRI/C-24 Retrieval Methods for Toxicological Case Information

The number of drug abuse cases, fatal and nonfatal, is on the order of 2 million cases per year. A complete toxicological investigation is essential in each case of death and in many nonfatal cases, so that ultimately the roles, direct and indirect, of specific exogenous chemicals may be assessed. An information storage and retrieval system of a generalized nature is desired for data from toxicological cases.

SRI/C-25 Photographic Methods for Surface Characteristics

Surface characteristics are often difficult to photograph because of problems of reflectance or lack of contrast, or both. Crime laboratories frequently have very minute characteristics as important items of evidence.

SRI/C-26 Educational Methods in Analysis

Approaches to the analysis of an unknown are critical elements in the education of a forensic scientist. The need is expressed for methods designed to enhance the orientation of a scientist to, or to guide the development of a student in, the selection of retrieval schemes for the informational contents from an object of evidence.

SRI/C-27 Residues from Hand Sweat or Film

Fingerprints left at the scenes of crimes are usually invisible and are found on a variety of surfaces. Fairly precise information as to the nature of the film found on human hands and the deposits from the film on various surfaces is needed. With this information, new and improved methods can be formulated for detection and retrieval.

SRI/C-28 Low Light Level Photography

A number of law enforcement agencies have expressed the need for an improved system to photograph individuals at low ambient light levels without alerting them. There are several commercial systems that supposedly perform this task, most using fast film and electronic light amplifications. Actual photographs exhibited by the police departments indicate that these systems are inadequate for identification of the persons depicted.

SRI/C-29 Enhanced Discrimination of Photographic Negatives

Documentation of crime scenes and related matters frequently includes photographs. While this form of recording is capable of storing information in high density at a low level of abstraction, the limitations of the human eye in discriminating monochromatic variations prevent retrieval of significant detail. The human eye's ability to distinguish color hues provides a method to retrieve the stored information.

SRI/C-30 Obliterated Serial Number Restoration

Serial numbers stamped in metal (firearms, motor blocks, and so forth) are filed or otherwise altered in an attempt to remove or change the identification. Methods are desired to retrieve the original numbers.

SRI/C-31 Material Source Analysis by Cathodoluminescence

Materials of both organic and inorganic nature can be differentiated by electron-stimulated luminescence. The characterization of gem stones and pottery by this means suggests an approach to source identification of physical evidence by comparison of suspected and known specimens.

SRI/C-32 Training Aids in Crime Scene Searches

The retrieval of possible physical evidence from crime scenes is handled largely by field investigators, i.e., from evidence technicians to patrol officers. Apprenticeship training, possibly with some direction by laboratory personnel, constitutes the basis for the investigator's recognition and collection of physical evidence. Training aids are needed to improve an investigator's perception of physical evidence during the learning process.

SRI/C-33 Morphological and Anatomical Analyses of Materials by Scanning Electron Microscope

Taxonomic development in physical evidence has been severely constrained by the rapidly decreasing depth of field with the increasing magnification of stereomicroscopy and microscopy and by the 100- to 200-nm resolution limit in microscopy. The scanning electron microscope provides vastly improved depth of field and resolution. There is interest in using this instrument to enhance potential evidence taxonomy.

Transportation

SRI/T-1 Origin-Destination Pattern

A very inexpensive, portable device that could "mark" a bus passenger as he enters the bus and identify him as he leaves would make possible the development of equipment to record data on the origin and destination pattern and fare mix of a transit system. This would greatly aid in effectively routing and scheduling buses, and reduce the number of transfers.

SRI/T-2 Vehicle Locator

Transit operators, police, and highway patrols need an inexpensive device to track a vehicle and compute its location coordinates for automatic reporting to a central dispatcher. A system that would transmit the vehicle's location when interrogated by the dispatcher would permit identification of its location when the officer is occupied outside the vehicle.

SRI/T-19 Nondestructive Measurement of the Thickness of Portland Cement Concrete Pavements

It is necessary in both newly laid and older Portland cement concrete pavements to determine the thickness with some degree of accuracy. For new pavements, measurement is necessary to ensure that construction specifications have been met. For older pavements, load carrying capabilities must be assessed. A rapid, inexpensive, and accurate method is needed to measure the thickness of the finished Portland cement concrete pavements, by nondestructive means.

SRI/T-20 Culvert Deformation

Highway builders use a great many corrugated steel culverts to carry water through highway fills. The present design formulae were developed for culverts buried in light or moderate fill heights. These may be inadequate for the high fills used in many modern highways. Equipment is needed to measure the deformation of a steel culvert during placement of the fill and for several years thereafter.

SRI/T-23 Measurement of Pavement Surface Texture

The skid-resistance of automotive tires is a function of the surface texture of the pavement. Several methods have been developed to measure texture and correlate it with skidding and hydroplaning, but all are time-consuming to use. A rapid test, preferably electronic, is needed to measure the surface texture of highway pavement.

SRI/T-24 Profile Measurement of Pavement Surfaces

Today's modern highways demand smooth surfaces to provide for safety and comfort at high speeds. Surface tolerances for new pavement construction are ordinarily given in terms of a maximum allowable vertical deviation from a true plane in a given horizontal distance. A high speed, accurate, profile measuring device to be operated at maximum automobile highway speeds is needed.

SRI/T-27 Reflective Signs

Highway signs use retro-reflective materials in the form of sheets or plastic buttons, all having a smooth, transparent surface covering. When this surface is covered with dew, the refraction and scattering of light from the water droplets destroy the retro-reflective character of the material. A material or coating is needed to preserve these retro-reflective properties in dew-forming conditions.

SRI/T-32 Impact Data Analysis

Highway laboratories test automobiles and wayside structures under impact to develop structures offering durability and maximum protection to the driver. Data resulting from impact tests must be compared with a passenger survival criterion. Prior to being used for this purpose, the data must be reduced to meaningful terms. Descriptions of both analog and digital techniques involved in filtering noise, integrating, and computing are desired.

SRI/T-35 On Site Compression Strength Measurements of Structural Pavement Sections

The strength of a given concrete varies with a number of factors, the most important being compressive strength of the cement paste, gradation and strength of the aggregates, the mix proportions, the water-cement ratio, and curing methods. A rapid, cheap and accurate method is needed to measure the structural strength of the finished concrete pavement.

SRI/T-37 Ultraviolet Degradation of Highway Signs

Currently the reflective material used on highway signs degrades after a period of time due to exposure to the sun's ultraviolet radiation. A method or process or a new material is needed that will prevent or resist the degrading effects of ultraviolet radiation in reflective materials.

SRI/T-38 Detection of Incipient Roller Bearing Failure on Rail Cars

Derailment is a typical consequence of bearing failure. A rate of failure that is tolerable in routine freight service will be intolerable in very high speed passenger service for which a lower friction, more reliable bearing than the journal bearing is necessary. Roller bearings are capable of long, trouble-free service, but they lack the early-warning characteristics of the journal bearing. Therefore, railroads follow strict rules about inspection procedures. In addition, bearings on cars that have been involved in collisions or derailment must be disassembled and inspected in an expensive shop operation. A device is needed to warn of incipient failure of roller bearings on rail cars.

SRI/T-39 Detection of Lock-In Stress in Long Welded Rails

Modern railroad track is laid in very long, continuous lengths of welded rails. Thermal stresses build up in such a strip, but are normally distributed along the rail. If ties, ballast, or anchors are disturbed by maintenance or repair work performed at a different temperature from that at which the rail was laid, stress may be relieved in one section and accumulate in another. On a hot day a sufficiently large compressive stress may build up to buckle the rail despite the lateral restraint by the ties and form a sun kink. A device is needed that can travel along a steel rail and measure its stress condition.

SRI/T-40 Nondestructive Testing of Rail Butt Welds

The quality of welds in continuous welded rail is very important to the safety of the resultant track. The shop welding process is fast. The welds are checked while still cooling by Magnaflux device; however, internal defects are easily missed. The ultrasonic test used in the field is not applied to shop welds because the necessary cooling time is too long. A nondestructive test is needed that can function with the rail at 500°F minimum, preferably to 900°F.

SRI/T-41 Creation of Properly Scaled Levels of Wind Turbulence and Gust Velocities for Wind Tunnel Tests

Techniques are needed for creating natural wind turbulence for spatial and temporal measurements in wind tunnels. Scale-model bridges, building, and so forth are studied with simulated wind conditions up to 100 mph. The model sizes are about 5 ft long and are studied in a 6-ft-square open throat wind tunnel.

SRI/T-42 Instrumentation for Close Range Photogrammetry

Measurement of the very slight motions of large structures such as bridge pilings, base structures, and large earth fills at distances of 20 to 200 ft is desired. In many cases, the item under study is inaccessible to routine types of instrumentation and measurement techniques.

SRI/T-43 Portable Device for Recording Eye Motion

A portable device is needed to monitor eye motion of vehicle drivers. How a highway sign is read, whether colors or letter sizes have an effect, whether flashing lights near a highway sign are distracting, and how fatigue, narcotics, and pollution combine with the other questions, are of interest to researchers in the highway sign field.

SRI/T-44 Frost Detection and Removal from Bridge Decks

Ice or frost on bridge roadways, at a time when the approach pavements remain ice- and frost-free, has been accepted as a safety hazard in many states. Because the bridge itself is exposed to moisture and winds from all sides, ice and frost generally form on the decks before appearing on the approaches. A detector is needed to indicate the formation of ice or frost on the roadway of a highway bridge. Also needed is a method, triggered by the detector, to remove such ice and frost.

SRI/T-45 Nondestructive Testing of Large Metal Structures

Methods are required to test large metal structures, especially bridges, for structural integrity. Solutions should consider the impedance to smooth traffic flow during testing, simplicity of the test, and reliability of operation. There are approximately 500,000 bridges on U.S. highways and no definitive way to determine which ones are structurally safe.

SRI/T-46 Improved Rear Vision Device

The lack of a clear 180° rear view from vehicles poses a continuous safety problem. An improved rear vision device is needed for motor vehicles.

SRI/T-47 Sewage Processor for Highway Rest Stops

Since most highway rest stops are located in rural areas, some thought must be given to preserving the ecological surroundings by thoroughly processing the sewage effluent from the comfort station. A self-contained sewage processing unit is desired, requiring little maintenance.

SRI/T-49 Air Purification for Toll Booths

There is a need for an economically feasible system for providing purified air to toll booths in an environment having a high concentration of compounds from vehicle exhausts.

SRI/T-50 Lightweight Scaffold Material

The cost of painting the San Francisco Bay Bridge amounts to more than \$1 million annually. An appreciable percentage could be saved by lessening the time required to move scaffolds and lessening the maintenance of the scaffolds. A strong, durable, lightweight scaffolding material is needed.

SRI/T-51 Corrosion and Contaminant Removal from Steel

To ensure the structural soundness of a bridge, it is necessary to periodically remove all corrosion and reapply protective coatings. Sand-blasting, the most successful method at present, requires expensive, bulky equipment and clothing. A method is needed to remove the corrosion and contaminants from bridges without leaving a harmful residue.

SRI/T-52 Nondestructive Testing of Cables

There is no nondestructive method for ascertaining the load-carrying capacity of the stranded cables used on bridges. Bridge loads are increasing, and public safety demands that a cable's conditions be known since wear, corrosion, or fatigue may drastically reduce its safety margin.

SRI/T-53 Concrete Repair Material

A strong, quick setting, nontoxic material is needed for repair of the concrete on bridge decks and approaches. The repairs must be completed during non-rush hours when closing a lane is less apt to impede the flow of traffic.

SRI/T-54 Flameless Pavement Heating Device

Many northern states are faced with the problem of repairing roads in below freezing weather. A device or method is needed to heat the asphalt pavement to a depth of six to eight inches.

SRI/T-55 Impact Resistant Rollers

The postal service uses conveyor belts to carry sacks of mail into and out of trailers. The sacks are stacked 7 ft. high, and in a typical trailer unloading they are swung down by the closure strings and dropped onto the conveyor belt. The resulting impact of about 400 foot-pounds damages the rollers.

SRI/T-56 Inexpensive Gas Compressor

The postal service is experimenting with natural gas as a vehicle fuel to reduce air pollution. The gas will be stored at 2000 psi in pressure vessels rather than in liquid form. Gas is furnished at line pressures ranging from 3 to 150 psig, depending on the length of pipeline from the well to the point of use. An inexpensive and effective system is required to deliver high pressure gas to the vehicles.

SRI/T-57 Concrete Sealant

A surface sealant is needed to prevent the admittance of moisture to and the associated deterioration of reinforcing rods in concrete. The soundness of structures, especially bridges, is endangered after prolonged exposure.

SRI/T-58 Instrumentation for an Impact Sled

Building of a pneumatic impact sled is planned for studying such things as collapsible dash panels.

SRI/T-59 Corrosion Protection for Submerged Pilings

Conventional construction practices require that the lower end of a piling be driven into mud and the upper end encased in concrete. A method is needed to stop or slow the galvanic corrosion by saltwater of the transition zone, the piling section not encased in concrete and not sufficiently sealed by the mud.

SRI/TR-60 Trackside Clearance Measurements

A device or method is needed by the railroads to monitor and maintain the minimum clearances between the rolling stock and surrounding obstructions such as tunnel walls, sides of buildings, bridge members, and signals. Changes in the clearances may be caused by earth movement, track maintenance and repairs, new construction, or even high or wide loads on the rail cars themselves.

SRI/T-61 Pavement Striping

Few pavement marking materials last longer than two years, some only two months. The markers may be abraded by tires, chipped by studded snow-tires, dislodged by snowplows, or peeled by moisture and frost. Replacement of striping is expensive, striping equipment impedes traffic, and the workmen are endangered. A durable pavement striping material is needed that is reflective in wet, dark periods when a driver's need for guidance is most critical.

SRI/TR-62 Improved Brake Lining Material

New materials for brake linings are greatly needed for increased
vice is anxious to increase the time
between relinings (600 to 6000 miles) for postal vehicles. The railroads are interested in new materials to replace the metal shoes currently in use on railcars. These metal shoes cause sparks that have set trackside weeds and boxcar bottoms on fire. In addition, wheels heated by metal linings tend to be thermally loaded and stressed.

SRI/TR-63 Fire Protection of Railroad Tank Cars

There is a need for fire protection and prevention of catastrophic failures of tank cars in postderailment environments. Fire retardant or protective coatings are required to maintain the 5/8-inch steel tank cars at 800°F or below for 1/2 to 4 hours during a fire.

SRI/TR-64 Detection of Residual Stresses in Rail Car Wheels

Derailments have occurred because of the catastrophic failure of rail car wheels. These failures occur when stresses resulting from known vertical and lateral operating loads are superimposed on unknown residual stresses in the wheel. There is a need for a method of inspecting rail car wheels in the field to determine if residual stresses are above a critical level.

SRI/T-65 Contour Plotting System for Highway Engineering

Large-scale maps with small contour intervals are needed for highway planning. A computer-generated, contour plotting system will be used to chart the areas being considered for highway construction.

SRI/TR-66 Railroad Ties

Wood, by far the most common material used for railroad ties, is in short supply and therefore expensive. In addition, it has a shorter life than most roadbeds. Sixteen million ties must be replaced each year and there is no adequate means for disposing of them. Material with greater availability and durability is needed--perhaps one that can be repaired instead of being replaced.

Postal Operations

SRI/PS-1 A Novel Method for Cancelling Stamps

Current cancellation processes require turning the letter so that the stamp meets the cancelling device. These machines have a rather high rejection rate, however, and a considerable fraction of the mail must be hand cancelled. A novel alternative method of cancelling stamps is being sought.

SRI/PS-2 Environmental Effects on Human Factors

A person's ability to perform various mental and physical tasks is influenced by his environment. In a postal facility, the noise, ventilation, lighting, and other factors may have a bearing on human comfort and performance. Information and techniques are sought to optimize the environment for maximum comfort, safety, and efficiency.

SRI/PS-3 Fluidics for Mail Handling

New advances in mail handling technology are incorporating pneumatic controls for moving and separating mail. Parcels move on a cushion of air; letters are lifted over airfoils and separated by degree of lift (weight). NASA technology in fluidic controls, lift theory, wing design, and nozzle configurations should be valuable in developing new techniques.

SRI/PS-4 Repairing or Rewrapping Damaged Packages

Each year the postal service must repair or rewrap approximately 10 million parcels damaged as a result of processing or faulty packaging by the mailer. Present methods of repair are taping, string-tying, heat sealing with a plastic wrap, or a combination of the three. A method is needed that is less costly in terms of man-hours and material.

SRI/PS-5 A Lightweight, Durable Mail Bag Material

At present, the primary containers for transporting mail are the canvas and Resintex (a tightly woven nylon) mail bags. Because of the frequent handling they receive and the assorted shapes and weight of the parcels they contain, mail bags are subject to excessive wear and tear, resulting in a considerable expenditure each year for repair and replacement.

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Appendix C

PAPERS AND PRESENTATIONS

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1. Text of Talk Given at 1971 Winter Convention on Aerospace and Electronic Systems, Institute of Electrical and Electronic Engineers, Los Angeles

POTENTIAL FOR TRANSFER OF AEROSPACE TECHNOLOGY TO NONSPACE PROBLEMS OF THE '70s

Charles J. Cook

Introduction

I wish to discuss how components and subunits of aerospace technology can be transferred to and thus be utilized in the solution of specific nonspace problems incident to the ordinary daily affairs of man; problems identified in areas such as transportation, criminalistics, air pollution, and the U.S. Postal Service.

After establishing some definitions and some perspectives on the problems of transferring technology, I wish to relate our SRI experience in attempting to create such transfers of technology on a systematic, formal basis rather than by accidental or fortuitous find. And finally, I wish to give you my evaluation of the potential for the systematic transfer of aerospace technology to nonspace problems of the 1970s.

I outlined my thoughts to one of our artists. Here is his impression of technology transfer. This may be a popular impression. (Slide 1)

Let me define technology transfer so we can have a common understanding of a much discussed, but rarely specified process. It is not technology forecasting, nor technological assessment, nor assessment of technology. But when science or technology generated and used in one context is reevaluated and implemented in a different context, the process is called technology transfer. This definition of technology transfer is consistent with most others.

Transferring technology can be very profitable. It was discussed with thoughtfulness, wit, and clarity by Ralph Siu in The Tao of Science. I heartily recommend this book to those who wish to put science in perspective with the real world. Many historians, as well as Sui, have pointed out with some smugness that when Germany and France were the leaders in developing science and technology, England transferred this knowledge to satisfy business purposes and became a world power. When England, in turn, became the leader and developer of science and technology, the United States applied that science and took a commanding lead in transferring technology and, with a then unrecognized flair, built a giant industrial complex and worldwide business enterprise. Recently, Japan brashly became the transfer nation and is reaping worldwide acclaim, attention, money, power, and obligations. Who will be next? The United States must. We can, because the capacity to transfer technology is a state of mind, a goal to attain if a nation wants to do so. And in this context I refer you to an article in U.S. News and World Report, January 18, 1971, p. 35, "Applying Science to Industry - Why America Falls Behind," by Myron Tribus, Dean of Engineering at Dartmouth College, Assistant Secretary of Commerce, and Senior Vice President of Xerox Corporation. He states the case well; I recommend this article highly.

To return to our theme. Nations do not perform the actual task of transferring technology -- individuals or companies must do this. For an individual, a single company, or a government agency, transferring technology is an art. It requires a skill, it requires a special attitude, and it can be learned. It can be done by individuals with many backgrounds -- scientific, engineering, business, etc., who want to solve problems by technical innovation. Nations can establish policies so their technical community can concentrate on developing such skills, just as they can develop armies, a scientific leadership, medical complexes, and great universities.

We at SRI have a relatively long history of studying the philosophy and methodology of transferring technology because this is a part of research. We are currently developing, on contract with NASA, transfers from the aerospace technological data bank to form solutions to problems in criminalistics, transportation, and air pollution that will be accepted and used by local, state, and federal agencies. We are not looking for arbitrary transfers into all segments of the marketplace.

B. Classes of Transfers

Let's look at technological transfers in more detail. There is a family of them, composed of three classes. We define them as first, second, and third order transfers, the order increasing with the level of transfer complexity. The easiest to effect is a first order transfer.

A first order transfer is one where the user of the technology and the originator share a common discipline and a common problem.

A medical device developed by NASA for the NASA doctor to measure the skin temperature of an astronaut during a space mission may be an ideal solution to a generic hospital problem and can be directly transferred -- techniques, equipment, and all to any hospital, clinic, or doctor's office. However, constraints of price, simplicity of operation, size, weight, and similar characteristics often must be adjusted by proper adaptive engineering before the technology can be transferred to any or all doctors.

This is a simple case: a doctor-to-doctor, common language, common nomenclature, common medical problem. Such transfers usually are obvious and occur readily and naturally.

A second order transfer is one where the user of the technology transferred and the originator of the technology share a common discipline, but not a common problem.

An apparatus was developed to nondestructively analyze very small dust samples collected in space for elemental and chemical composition. This same instrument (once again after proper adaptive

engineering was completed to satisfy user constraints) could be used by criminalists and police crime laboratories to classify and compare minute paint and dust samples to link the perpetrator of a crime or accident to the crime scene. Here the aerospace developer and the criminalist have common scientific backgrounds and tools and investigatory techniques, but the aerospace developer is unfamiliar with constraints placed upon the criminalist and his equipment by the forensic process -- and this lack obscures the transfer process. Indeed, a solution obvious in the eyes of an aerospace scientist may be technically correct, yet not be acceptable in today's forensic cycle. If so, it is not a solution for the criminalist today. However, if a champion could get the solution accepted by policemen, judges, lawyers for and against, juries, etc., it could be a solution for the future.

A third order transfer is even more complex; it is one where the user of the technology transferred and the originator of the technology share neither a common discipline nor a common problem.

Consider one problem in air pollution: A measurement system is developed by an upper atmosphere scientist to determine the NO concentration in the ionosphere. It is adaptable to measure classes of oxides, such as NO_x. An automotive engineer requires a device to monitor the exhaust of each assembly line auto as it rolls out and he must measure CO_x, NO_x, SO_x, and other simple molecules. He must show that the car meets existing and contemplated federal requirements. Furthermore, the results in the automobile factory must be obtainable by a factory worker who can tell another factory worker what is wrong; hence, how to fix the line. The machine must also be usable in service garages by mechanics. The mechanic will know cars but will not be knowledgeable about the upper atmosphere, nor understand the basic science, nor know the proper nomenclature. If a scientist is required to operate the test, the law cannot be upheld since no garage mechanic can perform the test or understand it. You no doubt recognize this picture and can fill in the details to complete this story at your leisure.

C SRI Experience

What has been our experience to date in our studies of transfers?

- The difficulty in effecting a transfer increases not linearly with order, but in some googolplex way; $1^1, 2^2, 3^3, 4^4$.
- Adaptive engineering is almost always required, either to make the new application financially competitive in the user's environment, or to make it acceptable to the users in its new environment. This latter factor is, indeed, a problem in public agencies where the new application may require new operating procedures and bureaucratic rules, if accepted, or in companies where union jurisdictional disputes may be created if the solution is utilized.
- For example, a nondestructive, pavement-thickness measuring device, as developed, may replace a coring crew. At the same time, it may create a serious perturbation in the highway department systems where operational procedures or existing laws require a coring crew, and union operating constraints may have to be revised.

Adaptive engineering is also often required to make a new application acceptable to the marketing system in which it must operate. A pavement-thickness measuring device must look like highway equipment, not space modules. The new application thus must be acceptable to the technicians using and servicing it.

- Timing is critical. We all know from repeated experience that technology is a frail commodity. Once a time gate is missed, the transfer process may need to rest and, at the right time, be reintroduced to ensure adoption.
- Some obvious examples: the air in highway toll booths is a winter problem every January and February, but not as great a problem in the summer when a wind is blowing and the windows are open. Metal detectors for a critical court case fall in the same category. An old sales adage holds here. It is profitable to sell to one who has already decided to buy; it is certainly expensive to sell to a man who has no need or interest at the time.

Let me summarize this situation and point out an additional key factor required in effecting transfers of technology (see Table I):

Table I
FACTORS REQUIRED IN TECHNOLOGY TRANSFER

Order of Transfer	Technology User/Originator	Problem Application User/Originator	Additional Factors
1	Common discipline	Common	A third party may occasionally help
2	Common discipline	Not common	Normally requires a third party
3	Not common discipline	Not common	Requires a third party

It may be that for all transfers the process could be greatly accelerated by an external catalyst, a third party. A third party can furnish two things:

- A language common to the users and originators, the technology and problems, and
- The broad perspective required to ensure that all the important factors and boundary conditions that must be met to introduce the new solution are satisfied. Normally, both the user and the originator lack this perspective.

And a word of caution: In many instances a fourth party is involved. For example, many solutions to pollution problems can be introduced to a specific public sector agency only by the concurrence of and, indeed, through the intervention of a federal agency which is not really interested in resolving problems amenable to technology transfer. It may be for this reason that many governments and companies tend to perform poorly at utilizing technology. It may be easier, bureaucratically, for each user to try to reinvent the technical basis for problem solution in his own language and format rather than adapt that which is available, because this process avoids third and fourth party complexities. Where this course is followed, inefficiencies are high and the transfer potential is low.

These comments on the fundamental problems met in attempting to transfer aerospace technology to serve as solutions to pollution problems are illustrated in the following figures.

Consider this hypothetical plot of the cost of pollution in loss of living quality, dollars, esthetics, etc., as a function of the dose rate of pollutants added to the system under question (Slide 2). Clearly there is a region of uncontested agreement by all individuals, government agencies, industry, etc. It is this region that spawns Los Angeles jokes like: "I shot an arrow into the air and it stuck."

However, for any problem considered, there is undoubtedly a threshold below which pollutant addition is of no consequence. And starting at that threshold, could it be defined properly, a most probable or actual locus for the cost as a function of dose rate can be determined (Slide 3). However, the region between the zero dose rate and the onset of total agreement is a realm of vigorous public debate. An obviously debatable question is: "Where in this realm is it rational to establish a maximum legal pollution dose rate that is tolerable?" Government agencies responsible for establishing a rate will undoubtedly place the legal rate somewhere in the debatable region. Once established, and for whatever reasons chosen, pressures build on both sides.

Some of the pressures exerted to increase the dose rate are derived from the costs of correction, technical limitations, consumption level, and economic factors (Slide 4). The counter pressures to reduce the acceptable legally defined dose rates stem from conservation group activities, the legal maze, control agencies, public health problems, and others.

The development is self-evident. The third party, or its wilfully constructed equivalent, is required to determine the active pressures creating a stable equilibrium and the effect of enhancing one pressure, that of a properly inserted technological solution, on the equilibrium point. Without a third party, two specific classical situations commonly prevail.

Cast in aerospace verbiage, they are:

- A solution to some problem seems evident from the aerospace technologist's point of view. Question: Where is the non-space problem it solves? And conversely,
- A problem has been defined in a nonspace sector. Question: Does a solution to that problem exist in the aerospace technology bank?

In either case the transfer is unlikely to take place without a third party, and the efforts to transfer are ineffective.

The first of these situations prevails for most scientists -- it is a most common problem in research organizations; it even persists at SRI. NASA's Technology Briefs address this problem; their data banks are available for computer search. But our mission for NASA is to resolve the mechanics to solve the second problem efficiently.

Let me illustrate the processes discussed by some actual cases.

Slide 5 shows a chronological time plot of important events that have occurred in transferring a NASA-developed reflectance spectrometer for very small samples (1 mm^2 or even less). A frequent problem in criminalistics (the crime lab) is to identify small paint chips. I referred to this problem earlier. If only 1/2% of fatal auto accidents could employ a paint chip analyzer to resolve a case before it reaches a court, it is estimated that \$1,000,000 in trial costs could be saved, not to mention dollars saved by speeding up the legal process. Add to that the similar factor for nonfatal but damaging accidents, $1/2\% \times \text{approximately } \$1,000,000 \times \$4,000 = \$20,000,000$, and this is a conservative estimate. So a reflectance spectrometer is an important device to transfer.

In this case, a problem was defined and we searched for a solution. We found it in NASA laboratories. We attempted a first order transfer, since the device is simple and the problems were related. It did not work well. The originator and the user of the technology were interested in a transfer but not

motivated to transfer and obviously, getting them together was not enough. So we became an active third party, not a coordinator. We had to, due to the budget stall -- it was stalled since the device was not forensic and could not become so unless the budget was approved.

We are now writing a definitive paper on the reflectance spectrometer, with the user and originator as co-authors, and this paper will be published to establish a forensic posture. The user, the originator, and the budget councils, but especially judges and lawyers, will then hopefully embrace the solution. The user and originator of the solution are now enthusiastic supporters of the transfer process.

The lesson? An active third party is required to motivate and thus help ensure a transfer.

Note -- the added cost of the transfer may be very small indeed.

Slide 6 is an example of a second order transfer in the law enforcement area. We noted a NASA technology brief, published in 1967, that was a beautiful solution to a generic problem. NASA required a simple test, nondestructive, to check metal part quality. A simple chemical test was developed and widely advertised.

Criminalists required a similar test on metal chips and tool scratches for burglary, forceful entry, collisions, and other cases where metal mark residues were found on metals or other materials. The need was to demonstrate that the mark was or was not made by a suspect tool. In this case a solution was just found and then the problem was identified. A solution was "sold" to the user.

However, we recognized a second order transfer and the transfer process proceeded rapidly to the test phase. This was simple, cost effective. The solution should be forensic and is obviously being received enthusiastically by the user.

Now for a third order, time-dependent case (Slide 7). A metal detector was required primarily by law enforcement officers so they could personally frisk individuals to determine if they were carrying a gun-like object without actually touching them, or they could use the same device to find bullets in walls and hidden metal objects in suitcases to protect courtrooms, etc. In this case we play Chinese baseball. I assume some of you know what Chinese baseball is like but, for those of you who do not, I will explain the game. Chinese baseball is played just like American baseball. It has the same number of players, the same size team, the same kind of ball and bat, and everything is identical to American baseball, except for one rule. In Chinese baseball, while the ball is in the air you can move the bases wherever you please, and Chinese baseball is exactly what we played in this particular instance. We started to solve a problem where essentially a metal frisker was required by the user. The user wanted a device where he could overtly conduct personal searches of luggage, etc. However, we were unable to transfer a solution to that problem in proper time. Although a solution was eventually found that satisfied his needs, his needs had changed by the time the solution was recognized by the user. By that time he needed a covert metal finder that would be suitable for mass searches, rather than an overt metal finder for individual searches. So we drifted then from a second order to a third order process because the class of individuals who became the users had also changed. Two factors had changed the priorities: One was the Algerian highjackers and the increased activity at that time in highjacking, and the other was the existence of some important court cases where the people entering and leaving a courthouse would have to be routinely searched. It now appears that the whole problem of metal detectors for search purposes is being taken over by a government agency, DOT, and whatever systems will be developed for either overt personal searches or covert mass searches will have to be introduced and certified by this fourth party. I brought up this particular case because its complexities

arose from the fact that we were unable to transfer the original solution within a time scale required to make it acceptable to a user.

Technology is indeed a frail commodity.

Potential for the '70s

So, what is the potential for transferring aerospace technology to nonspace problems of the '70s?

The potential for any one transfer is strictly dependent upon the Benefit/Cost ratio vis-a-vis the B/C ratio for R & D in the user's field ($B/C_T \nabla B/C_R$). The judgment on which way to go, R & D or transfer, depends upon the skills of the transfer agent (user, originator, or third party) and the mood of the decision makers.

We are at a crossroads. Until recently, science was considered by scientists as neither moral nor immoral, but amoral. The concern was to understand and master nature, to fill the data base. Now the pressures are building to utilize that base to the benefit of mankind, the nation, and our business, and not just fill it with interesting fact. The pressures to form an effective way to transfer technology will undoubtedly increase until better perspective is obtained concerning the balance between filling the myriad of technological data bases and transferring technology from one base to help solve problems of importance in areas not normally associated with that base.

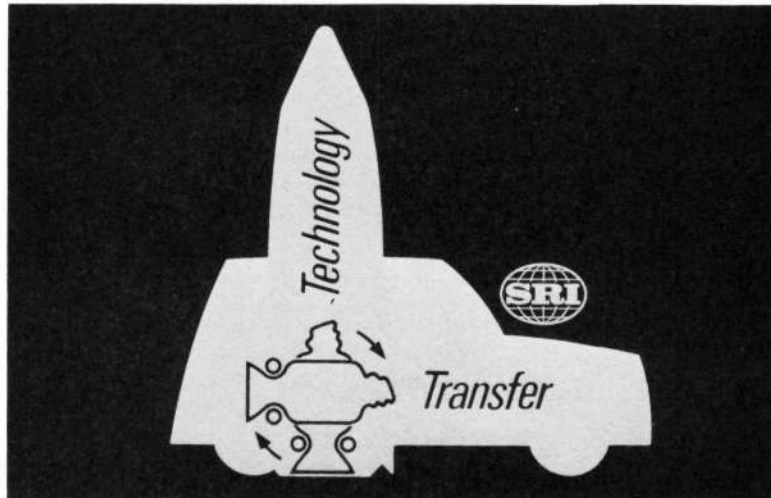
The need to develop transfer skills is being pointed out by national leaders with increasing frequency. We must learn how to transfer efficiently and thus convince our political leaders to apply our current broad technological base and skills to solve critical generic problems of, for example, the textile industry. We must help it to compete worldwide rather than kill it by making it a public charity through protective tariffs and subsidies that would be more expensive than the transfer costs.

The potential for transfer is high, since the data base is rich and basically untapped. It can be maximized if we, as aerospace engineers, are willing to adapt to application constraints in new fields, and if we are able to articulate to nonspecialists why and how the technological solution solves their problem. The potential is only a function of our ability to be flexible.

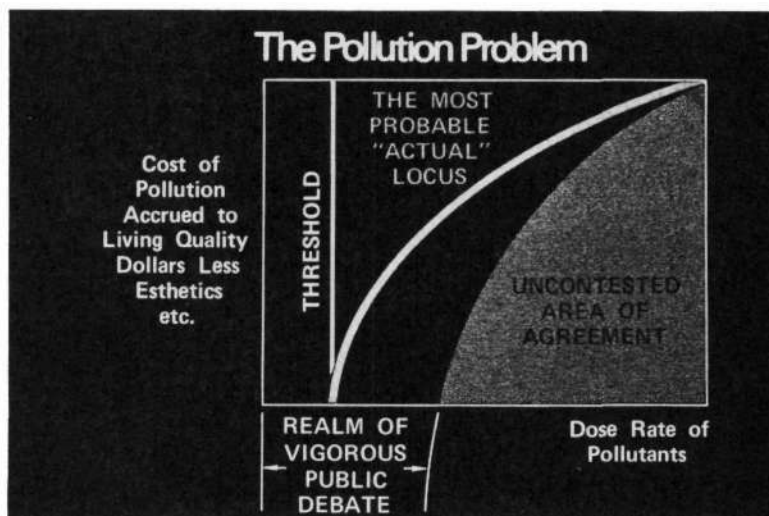
So, since the time is right, I expect $B/C T > B/C R$ in many fields and the potential for making transfers to increase through the mid 1970s. At the end of this technological half-life, the equilibrium rate between $B/C T$ and $B/C R$ processes will necessarily be defined. Transfer-making skills will be developed.

Then we should have maximum Gross National Product advance for our Nation, and security for ourselves.

But the ability to do so rests with us.

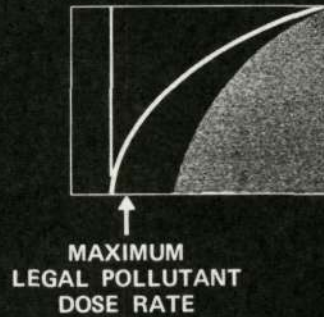


SLIDE 1



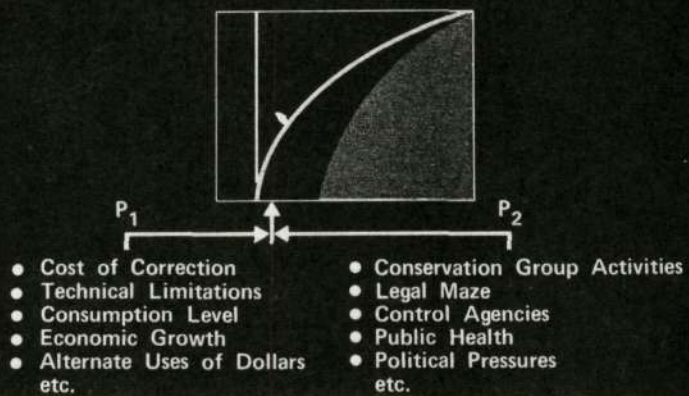
SLIDE 2

The Pollution Problem



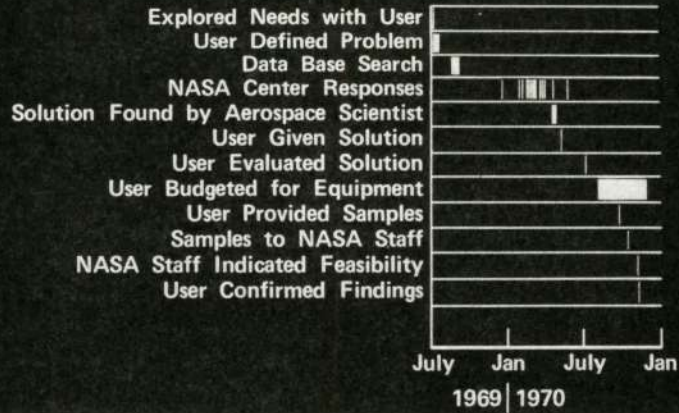
SLIDE 3

The Pollution Problem



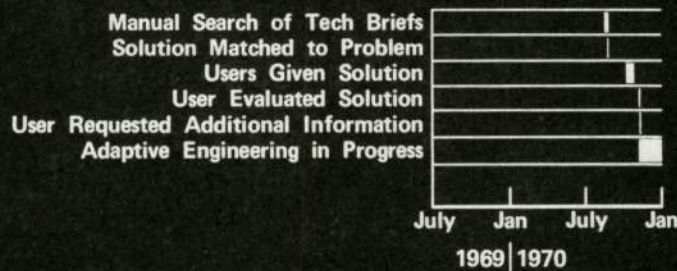
SLIDE 4

Reflectance Spectra / Small Samples



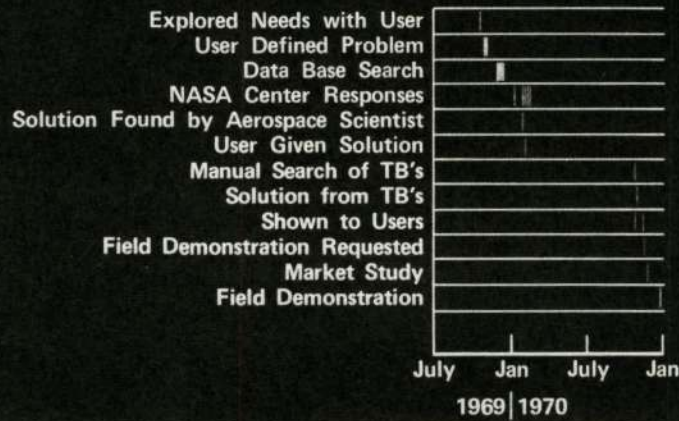
SLIDE 5

Simple Analysis Method for Metals



SLIDE 6

Metal Detector



SLIDE 7

2. Demonstration at California Driver Education Association Meeting, San Mateo, California, March 26, 1971

ALCOHOL EFFECTS ON HUMAN PERFORMANCE--A DEMONSTRATION

Seeing is believing describes the reaction to the recent demonstration on impairment of motor skills by alcohol consumption. At the 1971 Annual Conference of the California Driver Education Association in the Villa Hotel, San Mateo, volunteers* were tested for their performance abilities before and after drinking. For several hours the Conference attendees witnessed these performance tests conducted by personnel from the Santa Clara County Laboratory of Criminalistics† and from the NASA Technology Applications Team (TATeam) at Stanford Research Institute.‡

The initial arrangements for the demonstration were made by Mr. Walter C. Lunsford, Conference Chairman, with Mr. Lowell W. Bradford, Director of the Laboratory of Criminalistics. Director Bradford suggested the use of an instrument, the LRC Complex Coordinator located at SRI, to complement other tests of vision and manual dexterity. Mr. Joseph Berke and Dr. Brian Parker of the TATeam at SRI agreed to make the NASA-developed

* Anthony Steiner, Woodside High School, and Fred Quinn, John Busher, and James Burke of San Francisco School District.

† The Laboratory is a part of the Department of the District Attorney and is directed by Mr. Lowell W. Bradford. Staff members present were Messrs. A. Biasotti, Bryan Finkle, and D. Harding.

‡ The TATeam at SRI is sponsored by the Technology Utilization Office of NASA. Program monitor for NASA is Mr. Royal G. Bivins, Jr. This team is comprised of personnel from a variety of scientific and engineering disciplines with a mission to transfer aerospace technology to the public sectors of criminalistics, transportation, and the postal service. The director, Mr. Joseph G. Berke, along with Mr. Richard Blunt, Mr. James Engle, and Dr. Brian Parker, took part in the demonstration.

instrument available for the March 26th conference demonstration. Conditions for the demonstration were specified by Director Bradford, and a schedule of testing and drinking was prepared.

On the day of the demonstration, the volunteers started the tests at 3:00 PM. The series of tests included visual acuity and depth perception as measured by use of an orthorator, manual dexterity rated by performance time for reversing a set of sixty blocks, and coordination as determined by performance time and total errors on the NASA Complex Coordinator. During the tests, attendees watched the volunteers and had opportunities to try the test devices themselves. The pretesting was concluded by 5:00 PM at which time the drinking began. For the next hour and a half the volunteers consumed those quantities of alcohol calculated to bring their blood alcohol concentrations to $0.10\% \pm 0.02\%^*$ by 7:30 PM. A maintenance dose of alcohol was taken by every volunteer at that time to hold the blood alcohol concentration relatively constant during the posttest period. The testing equipment was transferred to the banquet room, and, as people gathered, the volunteers repeated the performance tests. In addition, each volunteer was checked for his blood alcohol concentration by means of a Breathalyzer.[†] The results showed the following types and degrees of impairment:

<u>Volunteer</u>	<u>Percent Blood Alcohol</u>	<u>Complex Coordinator</u>	<u>Manual Dexterity</u>	<u>Vision</u>	
				<u>Acuity</u>	<u>Stereopsis</u>
1	0.11%	-19%	-15%	-20%	-75%
2	0.07	-29	-13	-9	-50
3	0.08	-4	0	-8	0
4	0.11	-30	-8	-10	-70

* A blood alcohol concentration of 0.10% establishes a presumption of being under the influence for legal purposes in many states.

† The Breathalyzer is an instrument that measures the breath for expired alcohol and relates it to the blood concentration of alcohol.

None of the volunteers demonstrated any signs of overt intoxication such as stagger or slurred speech, yet a wide range of impaired motor skills were apparent. Officer Frank Fenlon, California Highway Patrol* gave one of the volunteers the typical roadside evaluation before the audience to demonstrate the difficulty of judging whether one is under the influence without chemical analysis of blood, breath, or urine. Since the human ability to learn rapidly could not be controlled in the demonstration, the individual performances, in part, represent impairment offset by improvement from adaptive learning. As noted by Director Bradford in the discussion after the banquet, experiments under controlled conditions show, at a blood alcohol concentration of 0.14% in the human being, all subjects suffer impairment of

Reaction time--lengthened

Manual dexterity--reduced

Visual ability

peripheral vision--reduced (tunnel vision develops)

distance acuity--reduced

stereopsis--reduced

Awareness of surroundings--reduced.

A two-page synopsis prepared by the Laboratory of Criminalistics on alcohol dosage and its effects on automobile drivers was furnished to all banquet attendees. Dr. Parker mentioned an experiment, under controlled conditions, with the Complex Coordinator and individuals having blood alcohol concentrations of 0.01%, 0.05%, and 0.10%. The same tasks performed by the Conference volunteers were used, in addition to some more complicated tasks. The experiment showed significant effects at all three blood alcohol concentrations on the individual subject's ability to make precision position movements of his limbs.

* Safety Education Officer, San Mateo County.

The demonstration gave emphasis to the drinking and driving statistics which show that the cost in fatalities, injuries, and property damage to the U.S. public exceeds a half billion dollars per year.

Alcohol's effects

Tests show drink-drive peril

By NED MACKAY

SAN MATEO—Four high school teachers got pleasantly drunk together Friday night at the Villa Hotel.

The four were volunteers to prove that even "social drinking" can impair driving skills and increase the chances of traffic accidents.

They held their drinking session during a conference of the California Driver Education Association, which is continuing at the hotel this weekend.

Presiding over the demonstration was Lowell Bradford, director of the Santa Clara County Laboratory of Criminalistics, a part of the district attorney's office.

"It seems to be a popular idea that it's okay to drink and drive if you're not drunk," Bradford said, "but you have to be almost stumbling drunk to be arrested for drunken driving in California."

SKILLS IMPAIRED

"After a few drinks," he continued, "you've got such a release of feeling you think you are a better driver than before, but this isn't true. Subtle skills are impaired, such as depth perception and reaction time. And the driver can't realize this." The demonstration proved his point.

The volunteers were first tested while sober, using a variety of devices. These included a "Minnesota manipulation" test, during which the volunteer inverted a series of wooden plugs in a race against a stop watch.

Another instrument tested each man's depth perception and visual clarity.

The third device, a complex coordinator, has been used by the National Aeronautics and Space Administration to test astronauts. The person being tested manipulates paddles and levers with his hands and feet to match light patterns produced by the machine. Bradford said

it is probably more complicated than driving an auto.

The volunteers were then given doses of alcohol in mixed drinks, varying with their weight and age, but all calculated to bring their alcohol level in their blood to .10 per cent—or 1 part alcohol per 1,000 parts of blood. This is the level at which California law considers any driver to be "under the influence" of alcohol and liable to arrest for drunken driving.

Bradford said that a blood-alcohol level between .05 and .10 per cent is sufficient for intoxication in many people.

"They're getting eight bar drinks," he said of the volunteers, "or four home drinks. They're like a group you'd see at most cocktail parties."

Conversation with the group supported his description. Jim Burke, 35, a San Francisco high school teacher, was asked how he felt. "With my hands . . ." Burke responded convivially, "No, I do feel different from normal. . . ."

'NO PAIN'

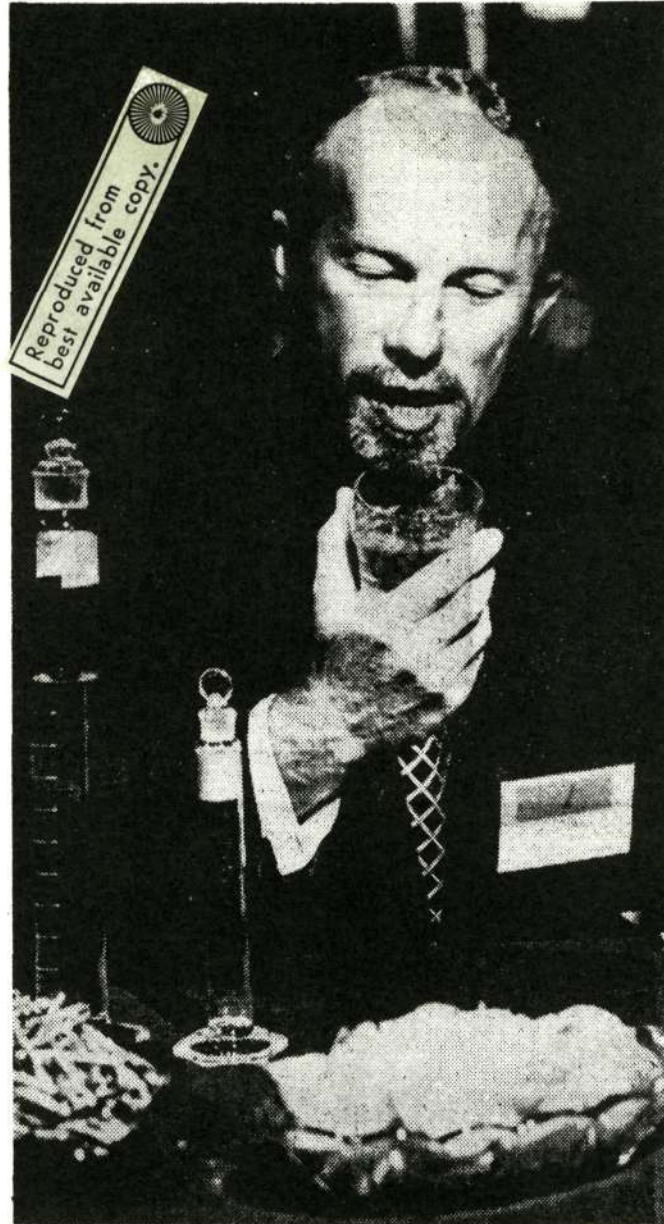
Anthony Steiner, 46, of Mountain View, a driver education teacher at Woodside High School, said, "I feel no pain. I'm glad I'm not going to be driving for a few hours."

Steiner said that he felt about the same as he would driving home from a cocktail party. "Driving becomes almost second nature," he said, "You feel supremely confident that you can handle it."

After about two hours of drinking the men were tested again on the same equipment.

Three of them—Burke, Steiner and driving instructor Fred Quinn of San Francisco—suffered a decline in manual dexterity, ranging from 8 to 15 per cent. Their visual clarity and depth perception also had deteriorated. Two of them had blood-alcohol levels above the .10 per cent legal limit.

The exception was John Busher, 24, a driver education teacher from San Francisco. Except for an 8 per cent reduction in his visual clarity,



One for the road?

Teacher Anthony Steiner of Woodside High School samples a drink—to prove how dangerous it is to drink and drive.

Busher was unaffected by the alcohol. In fact, he manipulated the complex coordinator faster, although he made more errors.

Busher said he is not a frequent drinker. The testers attributed his results to the "learning curve." When people perform the same tests twice, their skill increase may offset the effects of alcohol.

The volunteers said the demonstration strengthened their conviction that driving and drinking do not mix. All four presumably had arranged for friends to drive them home. Bradford did not plan to gather data on the effects of driving under the influence of a hangover.

Teachers 'Drunk' But Only for Driving Test

By GEORGE GOLDING

"I'm going to quit drinking, no, what I mean is, I'm going to continue drinking, but quit driving, I mean quit drinking and driving," said one school teacher.

"I feel drunk," said another, "I wouldn't go out and drive a car right now."

He had just finished being tested for coordination, dexterity, and vision, after belting down half-a-dozen drinks in an hour.

John Busher, a driver education teacher for San Francisco's high schools, had scored slightly better on two of the four tests, after drinking, than he did when stone sober. Yet he "felt" too drunk to drive.

Busher is one of those people who get progressively quieter when drinking.

Tony Steiner, the other teacher (from Woodside High School), is one of those quiet people who come out of their shells after a few drinks.

During the controlled drinking demonstration at last night's opening session of the California Driver Education Association,

Steiner got gabrier and gabrier. His speech became slightly slurred, his movements became just a little less certain.

Fred Quinn, another teacher, also became loud. But then he is an extrovert anyway, smokes a cigar and wears a goatee. None of them was drunk. The test had been designed to show that half a dozen drinks does affect a person's driving abilities, even though he is nowhere near "legally drunk."

Jim Burke was the most obviously under effects of alcohol. He also became loud, his viking-like beard wagged over his lavender necktie, and his wire-rimmed glasses seemed to blur over his eyes as he drank.

Highest blood alcohol content among the four was .11 per cent, just above the level when a person can be legally de-

scribed as "under the influence." Two others showed blood alcohol contents of .07 and .08 per cent. One of these had lost 50 per cent of his visual depth perception, the physical faculty which seems to go first.

That was exactly what the test was designed to show, said Walt Lunsford of Foster City, who had programmed the demonstration.

"It's sobering," said Steiner, "none of us have had more drinks than you would at a party. You'd be feeling no pain, you know, you'd be feeling good, confident, and all the time, this would be happening to you."

He was turning over a series of small blocks in a simple dexterity test called the "mini-sorter." The average testee could turn over the 60 blocks in their holes, in 60 seconds, when sober. After half a dozen drinks, it took them 70 or 80 or 90 seconds.

"I feel so clumsy," he said. Steiner's tests ran 10 to 30 per cent longer, with more mistakes, after his half a dozen drinks, than before.

Quinn's testing repeated that pattern. Busher scored a little worse on two tests, a little better on two others.

Burke's errors or failures ran as high as 75 per cent, after his drinking.

Each of the test drinkers had a "custodian" who sat with him, ate with him, drank with him, even went to the men's room with him, because part of the laboratory control included never letting the subjects out of sight of those running the tests.

The test were conducted by members of the Santa Clara County Criminalistics Department, and by criminalistic scientists from Stanford Research Institute.

All the drinking teachers were volunteers, who had heard about the proposed test during committee meetings which set up the nineteenth annual conference.

"I think it's a valuable learning experience," said one, as 190 other driver training instructors ate their banquet meal which opened the two-day session that continues today and tomorrow at the Villa hotel.



BEING TESTED on the "complex coordinator" developed by NASA for use in the astronaut program, is high school driving teacher Norman Haukaas of San Francisco, who was later dropped from the list of testees, as being too cautious. The complex coordinator requires that a person adjust each hand and foot, separately, to match a set of lights on the test panel. The machine records the number of errors made by each limb, as well as the total time taken to run through a series of 50 tests. Average time was around seven minutes. (Times photo)

3. Paper Published in Journal of Forensic Sciences, April 1971.

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Reflection Spectra of Small Paint Samples: A Potential Solution *

*Fred W. Paul, Ph.D.,** Paul M. Dougherty, M.S.,*** Lowell
W. Bradford, B.S.,† and Brian Parker, D.Crim.‡*

A frequent feature of hit-and-run cases is the presence of paint scrapings from the missing car. These range in size from 1 mm² surface area upward and are potentially valuable for tracing and identifying the fugitive automobile. Several criminalists reported that they used unaided eye identification to establish identity between these samples and comparison samples from suspect automobiles. It was stated that more objective instrumental comparison methods would be desirable because they could (1) provide evidence in quantifiable and reproducible form and (2) facilitate the identification of the car while it was being sought.

A problem statement (SRI/C-1) was composed and circulated to scientists at NASA centers, and the suggestion made by the senior author of this paper was tested experimentally by him

* Received for publication March 27, 1971. Accepted for publication April 3, 1971. This report derives from work done by Stanford Research Institute for the National Aeronautics and Space Administration under Contract NASw-1992. The Technology Utilization Division of NASA sponsors a Technology Applications Team at SRI to find applications of aerospace technology in criminalistics and other areas. The team identifies problems and locates appropriate solutions. This publication and similar ones serve to spread the solutions among the user public. NASA and SRI gratefully acknowledge the collaboration of the criminalistics community. The NASA contract monitor is Mr. Royal G. Bivins, Jr. The authors are indebted to G. W. Roche and W. J. Chisum for stating the problem.

** Goddard Space Flight Center, National Aeronautics and Space Administration.

*** Criminalistics Laboratory, San Mateo County Sheriff's Department.

† Laboratory of Criminalistics, County of Santa Clara, Department of the District Attorney.

‡ Stanford Research Institute.

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and evaluated by criminalists. The equipment modifications are given so that other criminalists may test the preliminary results presented in this paper.

Experimental Procedure

The paint sample is mounted in the integrating sphere which serves as the reflectance attachment of a visible ultraviolet spectrophotometer. Normally, a very small sample will show no measurable absorption in this position. The integrating sphere has as its interior surface a diffuse reflector. An entering light ray undergoes multiple reflections in random directions until it leaves by the exit slit. The number of these reflections is given, on the average, by the ratio of the area of the reflecting surface to that of the exit slit. The fraction of these reflections in which the light ray hits the sample is given by the ratio of sample surface area to reflecting surface area. Thus, the average number of times the ray hits the sample before exiting is the ratio of sample area to slit area. For very small samples this is much less than unity and no absorption is recorded. The method reported here increases the number of times the ray hits the sample by mounting a convex lens in the integrating sphere so that its focus coincides with the sample. This has the effect of enlarging the *apparent* sample surface approximately to that of the lens surface. Any ray that hits the outer surface of the lens is focused onto the sample and is reflected from it. Thus, the absorption signal is greatly increased and can be recorded in the usual manner.

Any of several commercially available spectrophotometers may be used. The principles of the modifications to permit the measurement of samples of small area will be the same for any of these instruments, but the details will be peculiar to each make of instrument. The detailed modifications described below were made on a Beckman DK2A spectrophotometer. The exit aperture of the monochromator section was stopped down to 1 mm diameter by taping a piece of shim stock containing a 1 mm hole over the aperture. At each port of the integrating sphere where the sample and comparison beams enter, a lens was inserted. The lens diameter, about 16 mm, was adequate to intercept all the radiation entering that port. The lens focal length was such that the 1 mm hole at the exit of the monochromator was imaged at approximately unit magnification on the corresponding exit port of the integrating sphere. At each port a piece of shim stock painted with a flat black paint was inserted. These pieces of shim stock were larger than the exit ports and each had a 1 mm diameter hole drilled in it. The samples to be measured were placed against the 1 mm hole at the exit port for the sample beam. A standard white surface was placed against the 1 mm hole at the comparison beam. Conventional spectrophotometric procedure was used to obtain reflectance curves with the instrument thus modified. The cost of the modification parts was less than \$10. The modification can be installed and adjusted in about two hours. Removal of the instrument and return to its usual operation mode require only five minutes.

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TECHNICAL SECTION

Results

A number of small (ca. 1×2 mm) samples of paint chips arising from actual cases were submitted to the Goddard Space Flight Center laboratory from the criminalistics laboratories of San Mateo County and Santa Clara County, California. Figure 1 shows a typical spectrophotometric recordings (Beckman DK2A) for two red paint chips. It is seen that there is a definite difference in the reflectance spectrum, as shown by the different relative reflectances at wavelengths in the region 550 to 650 m (5500 to 6500 \AA) (Table I).

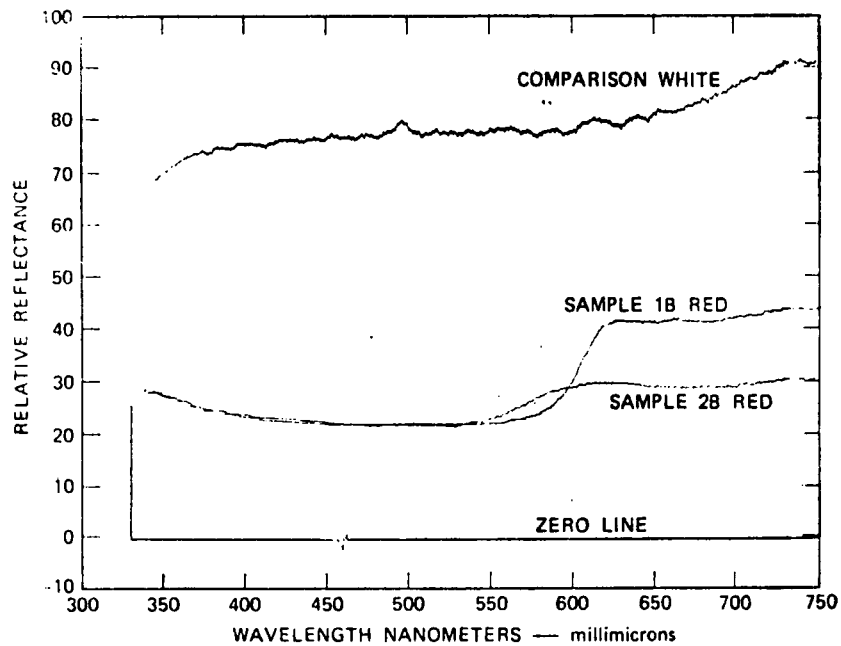


Fig. 1—Relative reflectance spectra of two dissimilar red paint chips and a comparison white paint chip.

TABLE I

Relative Reflectances and Reflectance Ratios of Two Dissimilar Red Paint Chips

Wavelength (n)	Sample 1B (%)	Sample 2B (%)	Ratio
550	22	23	0.96
575	23	26	0.89
600	30	29	1.04
625	41	29	1.42
650	41	29	1.42

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Summary

Requiring a minimum of additional equipment for most criminalistics laboratories, this very simple method will complement the capabilities of the laboratories to establish the facts of hit-and-run cases and other cases in which paint is a feature. It is hoped that this publication will lead to its use in suitable cases.

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